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# DRAFT
# Environmental Impact Statement
November 1977

# Sinclair Inlet
# Wastewater Facilities Project
## Kitsap County, Washington

DRAFT

Environmental Impact Statement

349

# DRAFT
# ENVIRONMENTAL IMPACT STATEMENT

## SINCLAIR INLET
## SEWERAGE FACILITIES PLAN
EPA Project No. C-530559

Prepared by

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
SEATTLE, WASHINGTON 98101

NOVEMBER 1977

Prepared with the Assistance of

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Approved by ______________________
Regional Administrator

Date October 26, 1977

A.

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## SUMMARY

## SINCLAIR INLET SEWERAGE FACILITIES PLAN
## KITSAP COUNTY, WASHINGTON

## DRAFT ENVIRONMENTAL IMPACT STATEMENT

Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

1. Type of Statement: Draft (X) Final ( )

2. Type of Action: Administrative (X) Legislative ( )

3. Description of Action:

The objective of this project is to provide a wastewater treatment and disposal system for the Sinclair Inlet Water Resource Inventory Area (WRIA) No. 15 within Kitsap County, Washington. This Environmental Impact Statement identifies alternatives for providing wastewater facilities designed to meet residential and industrial needs as well as the maintenance of environmental quality. The study area covers approximately 260 $km^2$ [100 sq mi] and has a population of 69,300, the majority of which is concentrated in the City of Bremerton.

Improvement of freshwater and marine water quality is a key issue in the Sinclair Inlet study area. Many areas in Kitsap County have experienced failures of septic tanks and drainfields due to hydraulic overloading, high groundwater levels and soils characteristics which are unsuitable for disposal purposes. This has led to bacteriological contamination of surface streams, lakes and shallow groundwater supplies in areas such as Wildcat Lake, Chico, Gorst and Blackjack Creeks. The majority of the wastewater treatment plants experience excessive infiltration and hydraulic overloading, which result in the discharge of inadequately-treated sewage into the marine waters. Recurrent stream pollution and contributions from the primary treatment plants have led to periodic bacteriological contamination of Sinclair and Dyes Inlet, as well as algal stimulation from excess nutrients. Sinclair Inlet is presently closed to commerical shellfish harvesting.

Facilities planning for the area began in 1975. Volume I - Planning Background was published in June 1976 and Volume II - Alternatives was completed in September 1977. The analyses of this Environment Impact Statement will be based on these two documents.

## 4. Summary of Environmental Impacts and Adverse Environmental Effects:

The type and magnitude of potential impacts vary according to the alternative proposed. Alternative 1 represents the no-action situation while Alternatives 2 through 5 represent different combinations of treatment and disposal locations. The impacts have been divided into: short-term impacts (construction), long-term impacts (operational) and long-term indirect impacts (secondary effects).

(1) Short-term impacts associated with construction include removal of groundcover, loss or transfer of soil resource, localized soil erosion, disruption of wildlife patterns, aerial pollutants, noise, visual impact, spoil disposal, traffic congestion, utility service disruption, safety hazards and water quality impairments. No short-term impacts will be associated with Alternative 1 (no-action).

(2) Long-term impacts associated with Alternative 1 include continued ground and surface water contamination by sewage, degradation of the marine environment due to the pollution of Sinclair Inlet, restrictions on shellfish harvesting and effects on land use and growth patterns.

Long-term impacts associated with Alternatives 2-5 include:

a. Protection of ground and surface water quality;
b. Incremental improvement of marine water quality in Sinclair Inlet over a period of time as compared to present conditions;
c. Long-term contribution of excess nutrients and trace pollutants which may stress the marine environment;
d. Increased energy demand;
e. Effects on local land-use patterns and property values;
f. Minor effects on vegetation and wildlife;
g. Impacts on the visual and aesthetic environment; and
h. Loss of water (treated effluent) and fertilizer (sludge) resource - unless arrangements are made for local sludge application.

(3) Long-term indirect impacts include those changes resulting from population growth accommodated by provision of sewer services, such as future construction in the sub-basin leading to erosion and subsequent stream pollution, loss of natural areas and wildlife habitat, loss of scenic resources, energy, utilities and service demands, and a long-term change in life style and quality of life.

## 5. Alternatives Considered:

Alternative 1 - No action alternative. This alternative would involve the continuation of existing treatment plant operations as well as the usage of individual septic tanks and drainfields. Associated with this alternative would be the continuation of periodic septic tank failures, as well as combined sewer overflows and hydraulic overloading of plants leading to pollution of Sinclair Inlet.

Alternative 2 - Charleston Regional/Retsil Regional/Manchester facilities with ocean outfalls. Charleston regional plant handles Manette and Charleston flows while Retsil regional handles Port Orchard and Retsil. Manchester is independent. Capital cost - $16,778,000.

Alternative 3 - Charleston Regional/Manchester facilities with ocean outfalls. Charleston facility handles Manette, Charleston, Port Orchard and Retsil. Manchester is independent. Capital Cost - $17,742,000.

Alternative 4 - Local treatment facilities with ocean outfalls. Manette, Charleston, Retsil, Port Orchard and Manchester are all enlarged. Capital cost - $17,769,000.

Alternative 5 - Charleston Regional/Manchester Regional facilities with ocean outfalls. Charleston regional handles Manette and Charleston while Manchester regional handles Port Orchard, Retsil and Manchester. Capital cost - $19,441,000.

6. The following state, federal and local agencies and interested groups were invited to comment on the Environmental Impact Statement:

## FEDERAL AGENCIES

Council on Environmental Quality
U. S. Army Corps of Engineers
U. S. Department of Agriculture
U. S. Department of Defense
U. S. Fish and Wildlife Service
U. S. Department of Interior
U. S. Department of Health, Education & Welfare
U. S. Department of Housing & Urban Development
U. S. Department of Transportation
Federal Energy Administration
National Marine Fisheries Service
Advisory Council on Historic Preservation
Naval Facilities Engineering Command

## MEMBERS OF CONGRESS

Warren G. Magnuson, U.S. Senate
Henry M. Jackson, U.S. Senate

## STATE AGENCIES

Department of Natural Resources
Bureau of Outdoor Recreation
Department of Ecology
Department of Fisheries
Department of Game
Department of Social & Health Services
Parks and Recreation Commission
Washington State Highway Department

## LOCAL AGENCIES

City of Bremerton
City of Port Orchard
Kitsap County Sewer District #1
Kitsap County Sewer District #3
Kitsap County Sewer District #5
Kitsap County Planning Department
South Kitsap Planning and Advisory Council
Puget Sound Council of Governments
Puget Sound Air Pollution Control Agency
Bainbridge Island Planning Commission

## OTHER

National Wildlife Federation
Bainbridge Island Concerned Citizens
The Bay Area Neighborhood
Kitsap Lake Neighborhood
Manette Neighborhood
Sheridan Neighborhood
Smith Neighborhood
BACON
League of Women Voters
Sierra Club
CH2M Hill

This Draft Environmental Impact Statement was made available to the Council on Environmental Quality (CEQ) and the public on November 25, 1977.

# SECTION I

A

# SECTION I

# INTRODUCTION AND SUMMARY

## BACKGROUND

Existing wastewater treatment facilities within the Sinclair Inlet drainage area of Kitsap County, Washington are under consideration for expansion to meet projected wastewater flows, and improvement to meet the goals of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). Seven jurisdictional entities in Kitsap County signed an interlocal agreement on 20 September 1974 for the purpose of jointly preparing a sewerage facility plan for the Sinclair Inlet area. These entities are:

1) Kitsap County;
2) City of Bremerton;
3) City of Port Orchard;
4) Kitsap County Sewer District (KCSD) No. 1 - Navy Yard City;
5) KCSD No. 3 - Manchester;
6) KCSD No. 5 - Retsil; and
7) Port of Bremerton.

Kitsap County and the City of Bremerton were authorized by the remaining jurisdictions to apply for and receive funding to prepare a facilities plan. A consultant was retained to prepare the Sinclair Inlet Sewerage Facilities Plan of which Volume I - Planning Background, was completed in June 1976 (Reference 1). Volume II - Alternatives, was completed in September 1977 (Reference 2). The final Plan is under preparation and will be ready in 1978.

EPA has determined that the proposed changes to the Sinclair Inlet wastewater treatment facilities will have significant environmental effects and has required the preparation of an Environmental Impact Statement (EIS) concurrently with the preparation of the facilities plan. This requirement is pursuant to Section 102(2) (c) of the National Environmental Policy Act of 1969, its amendments and the case law ensuing therefrom.

EPA is preparing this Environmental Impact Statement as documentation of: (1) the full consideration of possible courses of action to meet and maintain federal and state water quality standards as related to the Sinclair Inlet planning area; (2) the analysis of environmental and quality-of-life impacts of the alternative wastewater treatment systems; (3) EPA's decision-making process in determining its course of action at Sinclair Inlet; and (4) the involvement of other agencies and the citizenry in this process. The final EIS will serve as a statement of EPA's course of action on the Sinclair Inlet Sewerage Facilities Plan.

## PRESENT STATUS

The planning area of the facilities plan encompasses the natural drainage basins tributary to Sinclair Inlet in Kitsap County. The planning area boundary, as shown in Figure 1, includes sub-basins 11, 23, 24, 26 and 27 of Water Resource Inventory Area (WRIA) No. 15. The Kitsap County Airport (Port of Bremerton) and its associated development is also included in the planning area.

The population of Kitsap County has been growing at a rate greater than the State of Washington as a whole. The construction of the Trident Submarine Support Site and the expansion of the Puget Sound Naval Shipyard have attracted substantial new development to central Kitsap County. Many new housing developments are on temporary septic facilities awaiting connection to a regional facility. In some areas, the increased number of septic systems from new homes has led to the contamination of groundwater. The immediate need for sewerage service and treatment facilities is so pressing that a new regional treatment plant, as recommended by the Central Kitsap Wastewater Facilities Plan (Reference 3), will be constructed in the near future north of Brownsville. Thus the Sinclair Inlet facilities plan will not serve the bulk of the Trident-related growth but, nevertheless, will experience increased growth effects. On the basis of local estimates, the planning area had a population of 69,300 in 1975. Population estimates for the year 2000, as revised in September 1977 (Reference 2), project 89,000 persons within the planning area. These population estimates were used in the development of future wastewater flows and wasteloads for the facilities plan.

The Sinclair Inlet planning area is presently served by six wastewater treatment plants as shown in Figure 1. Bremerton provides sewage services to KCSD No. 1 and the Puget Sound Naval Shipyard. Bremerton operates two primary treatment plants at Manette and Charleston. The Manette plant currently handles 0.11 $m^3/s$ [2.6 mgd] which is discharged to Port Washington Narrows, while the Charleston plant treats 0.14 $m^3/s$ [3.1 mgd] and discharges to the northern portion of Sinclair Inlet. The City also operates numerous pumping stations, some of which overflow raw sewage to marine waters during wet weather. Port Orchard and KCSD No. 5 operate small primary treatment plants with outfalls to the southern portion of Sinclair Inlet. Flows in 1975 were 0.019 and 0.020 $m^3/s$ [0.44 and 0.45 mgd] respectively, for the two plants. KCSD No. 3 operates a small primary treatment plant with an average flow in 1975 of 0.001 $m^3/d$ [31,000 gal/day] discharging

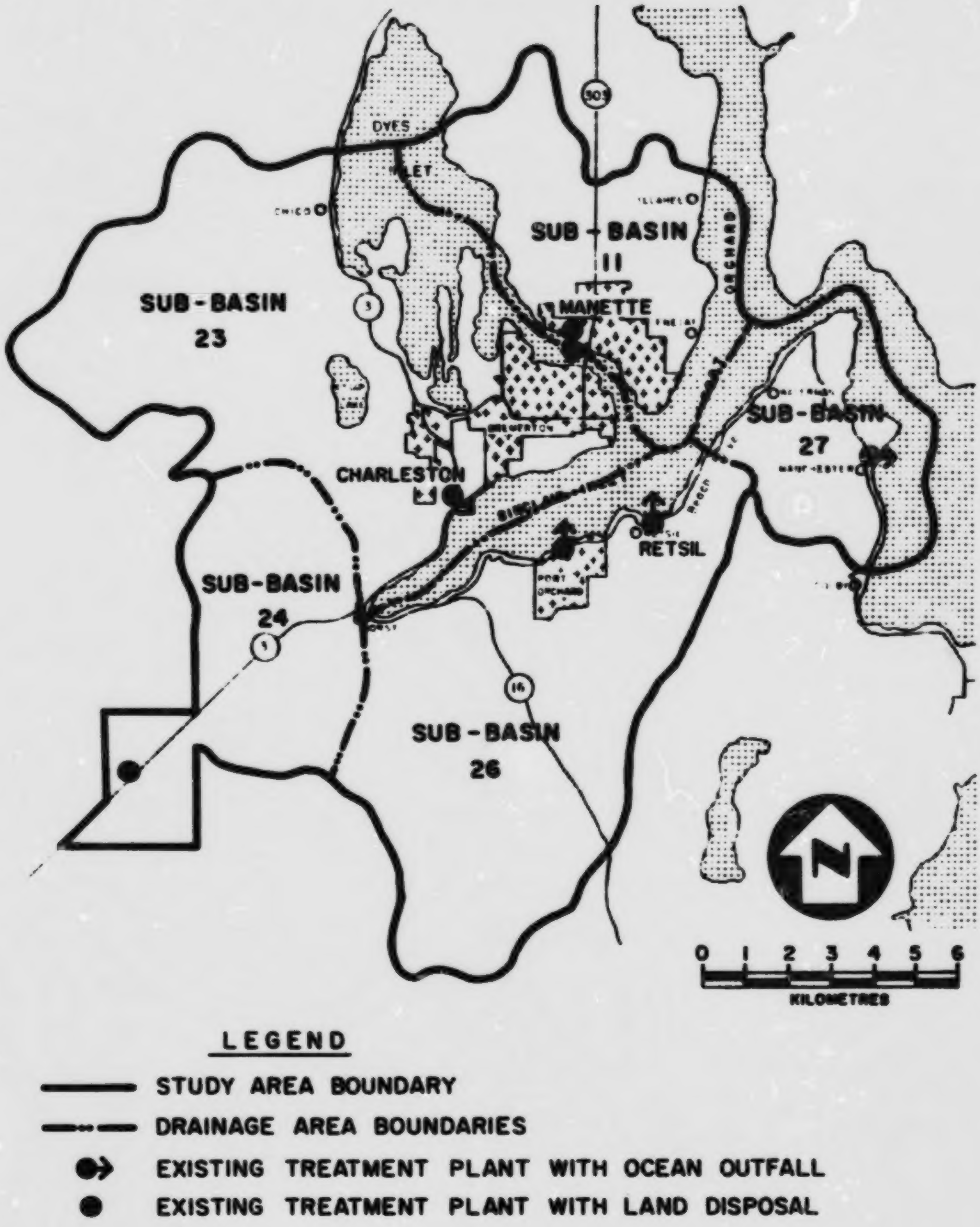

303
DYES
INLET
CHICO
ILLAHEE
SUB - BASIN
11
ORCHARD
SUB-BASIN
23
3
MANETTE
BREMERTON
CHARLESTON
SINCLAIR INLET
PORT ORCHARD
RETSIL
SUB-BASIN
27
MANCHESTER
SUB-BASIN
24
3
16
SUB - BASIN
26
N
0 1 2 3 4 5 6
KILOMETRES
LEGEND
STUDY AREA BOUNDARY
DRAINAGE AREA BOUNDARIES
EXISTING TREATMENT PLANT WITH OCEAN OUTFALL
EXISTING TREATMENT PLANT WITH LAND DISPOSAL

FIGURE 1 SINCLAIR INLET WASTEWATER FACILITIES PLANNING AREA

to Puget Sound. The Manchester Naval Fuel Depot has plans to discharge its ship waste to the KCSD No. 3 system in the near future. The Port of Bremerton operates a small secondary treatment facility handling a daily maximum of 0.0004 $m^3$/day [10,000 gal/day], which is discharged to a nearby drainfield. This is the only facility which does not have a marine discharge. It is not planned to connect this facility to a regional treatment plant in the near future, and therefore, it is not considered further in the facilities plan impact assessment.

The primary wastewater treatment plants within the planning area all experience problems with liquid-handling processes due to hydraulic overflows caused by excessive infiltration and inflow during wet weather. As developed under P.L. 92-500, the National Pollutant Discharge Elimination System (NPDES) permits for each facility require future secondary treatment levels. Upgrading of these facilities is necessary in order to keep pace with growth in the area and to restore and maintain a high-quality marine environment in Sinclair Inlet. The treatment plant effluents historically have been a source of marine pollution to Sinclair Inlet. High biochemical oxygen demand (BOD), suspended solids and dissolved nutrients have produced a long-term stress upon the marine environment. Effects upon the marine system include loss of sensitive fish and invertebrate species from the area and selection for low-diversity ecosystems with pollutant-tolerant species.

Another major consideration for marine water quality is the effects of nonpoint source pollutants. The planning area has experienced numerous failures of septic tanks due to hydraulic overloading, high groundwater levels and soil characteristics which are unsuitable for disposal purposes. Other areas of concern within the county are the bacteriological contamination of freshwater streams, lakes and water supplies, as well as of marine waters, in the planning area. The facilities plan identifies the following reported problem areas: Wildcat Lake, lower Sinclair Inlet at Gorst, the Manette peninsula facing Port Orchard, Beach Drive between Retsil and Point Glover, Beach Drive between Manchester and Colchester, Rocky Point, Chico and portions of Tracyton. High fecal coliform bacteria counts, an indicator of bacteriological contamination, are largely attributed to septic tank failures, sewer overflows and treatment plant upsets. All of the major creeks such as Chico, Gorst and Blackjack Creeks, along with the larger lakes, have exceeded state coliform standards. Recurrent stream pollution and contributions from surface runoff have led to the periodic bacteriological contamination of the nearshore waters of Sinclair Inlet. The inlet is presently closed to commercial shellfish harvesting.

# SUMMARY

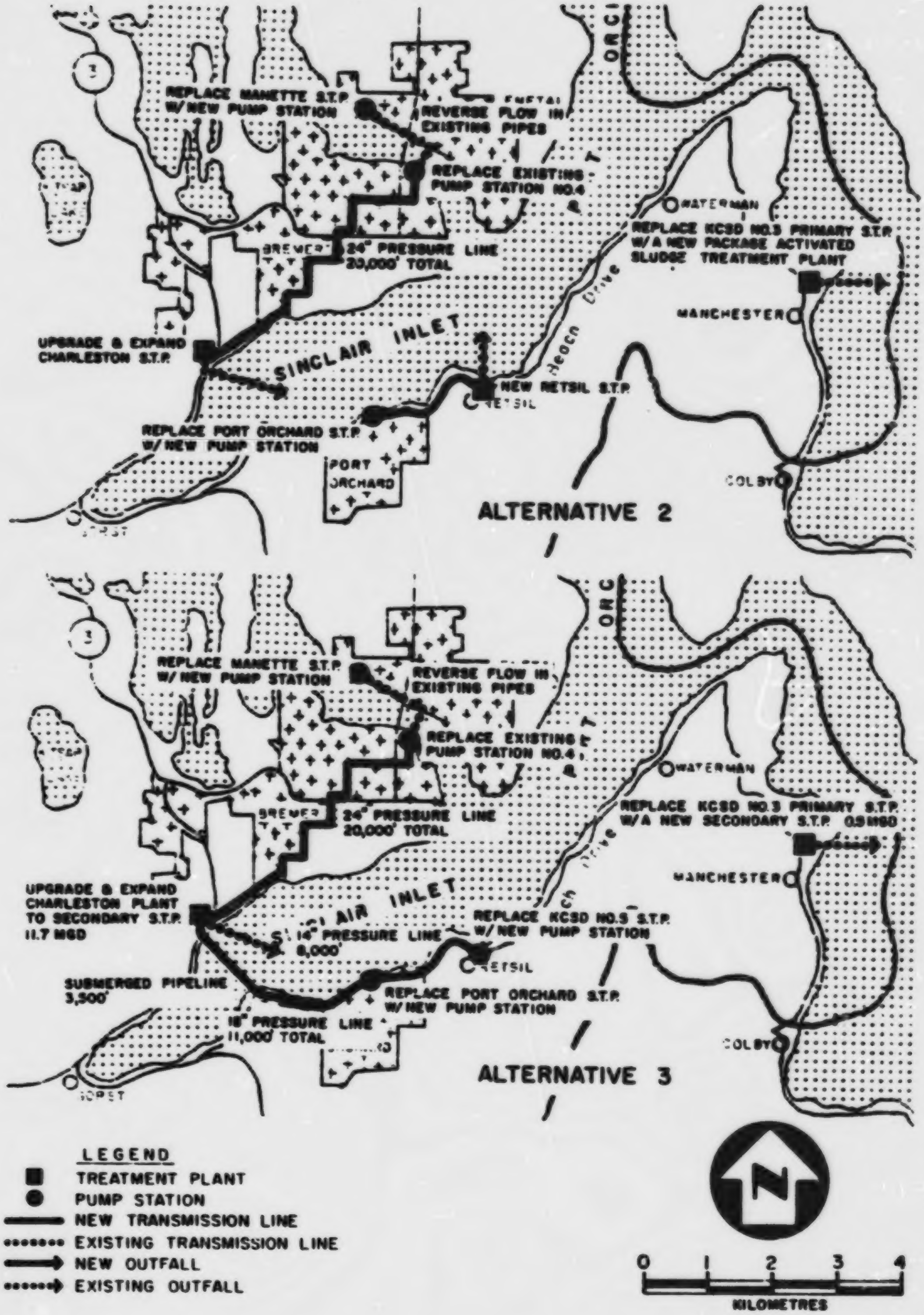
Five alternative plans were evaluated. All plans are based on the discharge of wastewater treatment plant effluents to Sinclair Inlet. This summary contains a brief description of each alternative and addresses the *major* issues of the project. These issues have been identified as: the effects on marine water quality from wastewater effluent discharged into Sinclair Inlet; construction disturbances along the lower Sinclair Inlet shoreline; population growth permitted by expansion of sewerage service and treatment plant capacity; economic impact on the community from facility construction, operation and maintenance costs; and the expected benefits from implementation of a wastewater management system. Alternative plan number 1 is designated as the "no action" alternative. Alternative plan numbers 2 through 5 are correlated with those developed in Volume II, Chapter II of the facilities plan. The alternative treatment plant locations, pipeline routes and outfall sites are shown in Figure 2.

## Alternative Plans

### Alternative Plan No. 1 (No Action)

Under the no-action alternative, the five existing primary treatment facilities and marine outfalls as described in the preceeding "Present Status" section would be retained. As each facility is presently at or above its handling capacity, future connections to the sewer system and expansion of the service area would be greatly limited. Installation of septic tanks and leach fields for new structures would be evaluated on an individual basis by the County Health Department. Associated with this alternative would be the continuation of periodic septic system failures and pollution of shallow groundwater aquifers.

Marine water quality in the Sinclair Inlet planning area would continue to be affected by the discharge of wastewater effluent high in coliform bacteria, organic material, suspended solids, dissolved nutrients and, at times, residual chlorine. Areas where water quality and the marine environment will be affected include the shallow waters of Sinclair Inlet near Gorst, Port Orchard, Retsil and to some extent, Dyes Inlet. Long-term pollution effects on the marine environment are reductions in the population of sensitive fish and invertebrate species, overstimulation of nuisance species (i.e. algae), contamination of shellfish resources, public health hazards and deterioration of aesthetic qualities. Continuance of the present discharge system would also be contrary to the goals of P.L. 92-500 and in direct violation of the NPDES discharge limitations.


REPLACE MANETTE S.T.P W/ NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P W/ A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
BREMERTON
24" PRESSURE LINE 20,000' TOTAL
MANCHESTER
UPGRADE & EXPAND CHARLESTON S.T.P.
SINCLAIR INLET
Beach Drive
NEW RETSIL S.T.P.
RETSIL
REPLACE PORT ORCHARD S.T.P W/ NEW PUMP STATION
PORT ORCHARD
COLBY
ALTERNATIVE 2
GORST
REPLACE MANETTE S.T.P W/ NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P W/ A NEW SECONDARY S.T.P. 0.9 MGD
BREMERTON
24" PRESSURE LINE 20,000' TOTAL
MANCHESTER
UPGRADE & EXPAND CHARLESTON PLANT TO SECONDARY S.T.P. 11.7 MGD
SINCLAIR INLET
14" PRESSURE LINE 6,000'
REPLACE KCSD NO.5 S.T.P. W/ NEW PUMP STATION
RETSIL
SUBMERGED PIPELINE 3,500'
REPLACE PORT ORCHARD S.T.P. W/ NEW PUMP STATION
18" PRESSURE LINE 11,000' TOTAL
COLBY
ALTERNATIVE 3
GORST
LEGEND
■ TREATMENT PLANT
● PUMP STATION
NEW TRANSMISSION LINE
EXISTING TRANSMISSION LINE
NEW OUTFALL
EXISTING OUTFALL
N
0 1 2 3 4
KILOMETRES

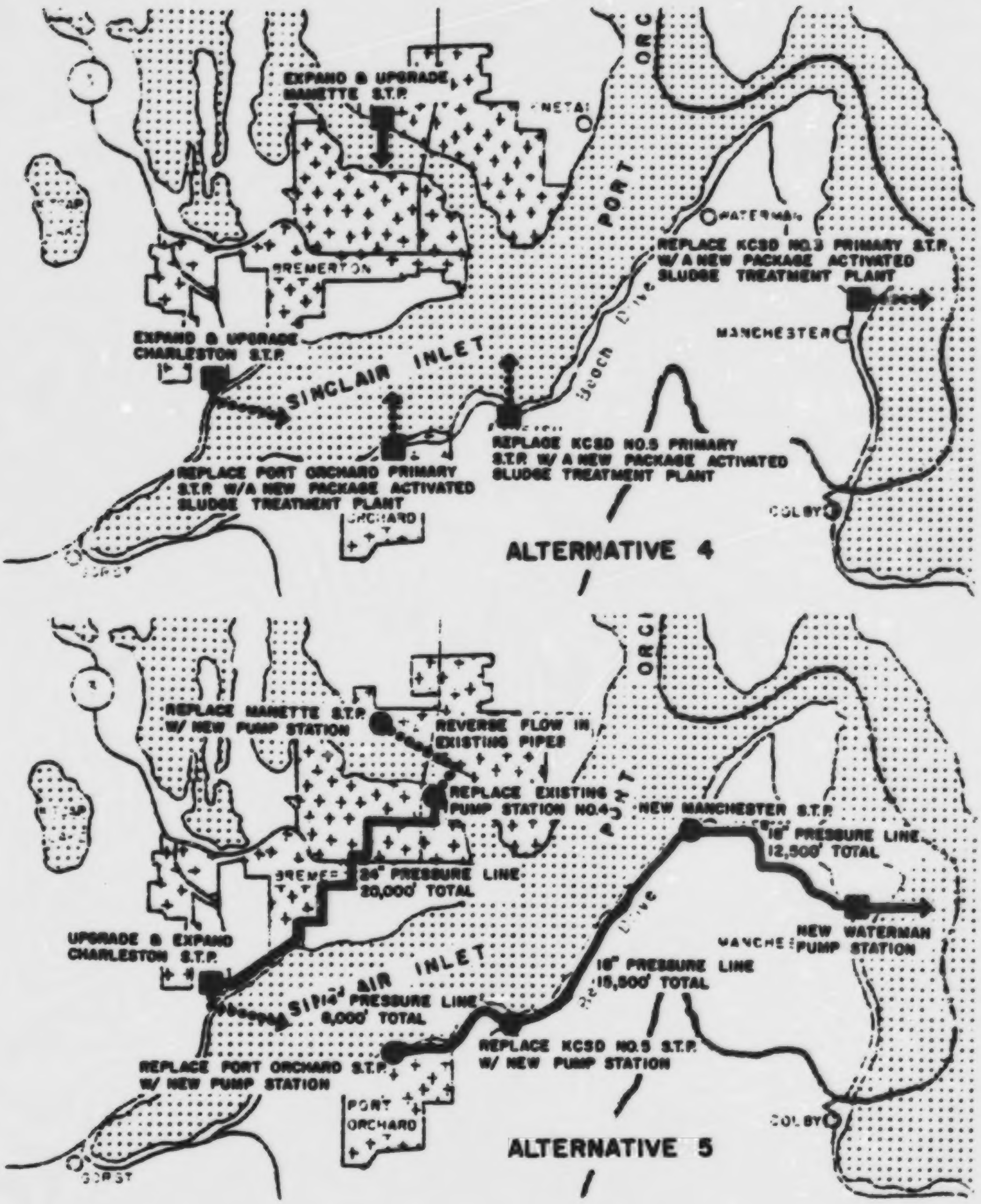

EXPAND & UPGRADE MANETTE S.T.P.
ENETAI
PORT ORCHARD
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P. W/ A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
BREMERTON
EXPAND & UPGRADE CHARLESTON S.T.P.
SINCLAIR INLET
Beach Drive
MANCHESTER
REPLACE KCSD NO.5 PRIMARY S.T.P. W/ A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
REPLACE PORT ORCHARD PRIMARY S.T.P. W/A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
ORCHARD
COLBY
GORST
ALTERNATIVE 4
REPLACE MANETTE S.T.P. W/ NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
PORT ORCHARD
NEW MANCHESTER S.T.P.
16" PRESSURE LINE 12,500' TOTAL
BREMERTON
24" PRESSURE LINE 20,000' TOTAL
UPGRADE & EXPAND CHARLESTON S.T.P.
SINCLAIR INLET
14" PRESSURE LINE 8,000' TOTAL
16" PRESSURE LINE 15,500' TOTAL
Beach Drive
MANCHESTER
NEW WATERMAN PUMP STATION
REPLACE KCSD NO.5 S.T.P. W/ NEW PUMP STATION
REPLACE PORT ORCHARD S.T.P. W/ NEW PUMP STATION
PORT ORCHARD
COLBY
GORST
ALTERNATIVE 5

FIGURE 2 SINCLAIR INLET DISCHARGE TRANSMISSION / TREATMENT ALTERNATIVE PLANS

## Alternative Plan No. 2 (Charleston Regional/Retsil Regional/Manchester)

Wastewaters from Bremerton and portions of Dyes Inlet and Wildcat Lake would be collected and treated at an expanded and upgraded secondary treatment facility at the Charleston site. The facility would be designed using an activated biological filter (ABF) to serve a population of 53,000 with an average flow of 0.4 $m^3/s$ [9.2 mgd]. Treated effluent will be discharged to Sinclair Inlet through the existing Charleston outfall. The Manette facility will be abandoned and flows pumped to the Charleston facility. Port Orchard wastewater will be pumped to Retsil where a new secondary treatment facility using rotating biological surfaces (RBS) will be constructed. The facility will serve 16,700 persons with an average flow of 0.11 $m^3/s$ [2.6 mgd]. Treated effluent will be discharged to Sinclair Inlet near Retsil. The Manchester facility will be upgraded to secondary treatment with RBS, serving 3,300 persons with an average flow of 0.02 $m^3/s$ [0.5 mgd].

The major impetus for population growth in the area and associated demands upon utilities and municipal services is related to expansion of the Puget Sound Naval Shipyard and to a certain extent development of the Trident Support Site. The northern portion of the planning area has already experienced substantial uncontrolled growth which is not served by centralized wastewater treatment facilities. Expanded and improved sewerage facilities will therefore serve existing new development as well as anticipated growth. In the less densely populated southern and eastern portions of the planning area, expanded sewerage and treatment facilities would have a tendency to direct future growth toward sewered areas. This would facilitate County efforts to control the location of future development. This impact is identical for all subsequent alternative plans and will not be addressed again.

Placement of a proposed pipeline route along roads and established rights-of-way between Manette and Charleston will have significant short-term impacts on traffic, aesthetics and utility services. On the south shore of Sinclair Inlet, pipeline placement in the subtidal and intertidal lands between Port Orchard and Retsil will have negative short-term impacts on small-boat navigation, marine vegetation and benthic communities, marine water quality and aesthetics. Careful construction practices could mitigate these impacts, but they are nevertheless unavoidable. Disruption of land use and local patterns would occur with the removal of six homes at the Charleston site.

The major treated effluent submarine outfall would be located in Sinclair Inlet near Charleston at a 12-18 m [40-60 ft] depth. Modeling results indicate that first mixing and dilution of effluent would be fair-to-poor and that subsequent dispersion and flushing would be poor. Initial dilution could provide 100:1 dilution only 25 percent of the time, thus effluent would be diluted poorly. Due to the poor circulation within this inlet, diluted effluent would be the receiving water for more effluent. Secondary-level treated effluent discharged at Charleston and Retsil would improve local water quality compared to the present situation. However, chlorine residual would be a problem for marine life. This alternative represents an immediate solution that best accommodates the existing jurisdictional entities. Pollution effects will be alleviated, but the long-term productivity of the marine environment would not be comparable to the complete cessation of discharge to Sinclair Inlet.

Project benefits for this and all other alternatives are basically identical as the outlying portions of the planning area become sewered. Substantial groundwater and potable water supply pollution from inadequate and failing septic tank drainfields will be greatly reduced. Public health risks from contaminated wells will be reduced, and it is expected that secondary level wastewater treatment with appropriate disinfection measures will reduce bacterial pollution in all adjacent marine waters. These project benefits accrue for all alternative plans and will not be repeated subsequently.

This alternative was ranked as one of the two lowest in project costs.

### Alternative Plan No. 3 (Charleston Regional/Manchester)

This alternative involves a regional secondary treatment plant at Charleston consolidating the four treatment plants in the vicinity of Sinclair Inlet. Flows from the Manette facility, Dyes Inlet and Wildcat Lake will be conveyed across Bremerton to the Charleston site. Retsil and Port Orchard flows will probably be conveyed in a submerged pipeline from Retsil west to Ross Point and then across the inlet to Charleston. The facility would be sized to handle an average flow of 0.5 $m^3/s$ [11.7 mgd]. The facilities planner did not designate a specific treatment process. It is presumed that it would be similar to Alternative 2. The Manchester facility will remain independent and will also be upgraded to a 0.02 $m^3/s$ [0.5 mgd] secondary treatment plant similar to Alternative 2.

Pipeline construction in this alternative represents the most significant short-term impact. Land routes for pipelines through downtown Bremerton, Port Orchard and Bay Street/Beach Drive between Retsil and Port Orchard would cause significant traffic disruption and interference with life styles. Alternative pipeline construction in the subtidal and intertidal lands between Retsil and Ross Point would cause disruptions to the marine community and shoreline areas. Construction effects would probably be the greatest on this alternative due to greater lengths of submerged pipeline route required. Removal of six homes would also be required at the Charleston site.

All treated wastewater flows, except for Manchester, would be discharged to Sinclair Inlet near Charleston. Dilution and flushing conditions are similar to those described in Alternative 2. The volume of effluent discharged at Charleston would be approximately 20 - 25 percent greater than in Alternative 2 and thus would slightly increase the ambient background level of diluted effluent in the inlet. Long-term effects of this discharge are similar to those discussed in Alternative 2.

This alternative was ranked as one of the two lowest in total project costs.

## Alternative Plan No. 4 (Local Treatment Plants)

Under this plan each existing facility is upgraded to the secondary treatment level. The Manette plant will treat and discharge 0.9 $m^3/s$ [4.4 mgd] to Port Washington Narrows. The Manchester Plant will treat and discharge 0.02 $m^3/s$ [0.5 mgd] to Puget Sound and the remaining Charleston, Port Orchard and Retsil facilities will treat and discharge 0.24, 0.019 and 0.020 $m^3/s$ [5.4, 1.0 and 0.9 mgd] respectively, to Sinclair Inlet. This alternative will involve no major new pipeline routes.

Localized construction impacts at each facility will be moderate to significant, depending upon the amount of land required. Significant disruption of land use and local patterns would result from construction at the Manette site which requires the removal of 25 homes. This would also occur to a lesser degree at the Charleston and Port Orchard sites. The Port Orchard site is an aesthetically poor location for a wastewater treatment facility because of its shoreline location and high visibility.

Discharge of secondary-treated effluent to Sinclair Inlet by the Charleston, Port Orchard and Retsil facilities will undergo similar dilution and dispersion characteristics as in Alternatives 2 and 3. Modeling results indicate that initial mixing and dilution of the effluent would be fair and subsequent dispersion and flushing would be poor. Effluent discharged at Port Washington Narrows from the Manette facility would achieve good initial dilution due to the strong tidal movements. Dispersion would be fair to good.

Alternative 4 does not involve pipeline construction costs or land and easement costs for the pipeline. However, land acquisition costs for each treatment plant facility, particularly Manette, can be significant. Therefore, this alternative was ranked as one of the two highest in total project costs.

## Alternative Plan No. 5 (Charleston Regional/Manchester Regional)

Wastewater flows from Bremerton and portions of Dyes Inlet and Wildcat Lake would be collected and treated at an expanded and upgraded secondary-level treatment facility at Charleston. The flows and treatment processes would probably be similar to Alternative 2. The Port Orchard and Retsil facilities will be demolished and flows pumped to Manchester where a new secondary level treatment facility will be constructed. The average flow will be 0.105 $m^3/s$ [2.4 mgd]. No treatment process was designated by the facilities planner.

Pipeline construction impacts will be the greatest with this alternative due to the extensive pipeline requirements. Pipeline routing through downtown Bremerton will have short-term traffic and circulation effects. Pipeline construction in the subtidal and intertidal lands between Port Orchard, Retsil and Waterman will have significant short-term negative effects on the marine environment, and may include long-term effects in some cases. Damage to the benthic marine environment is unavoidable; however, several construction techniques can be employed that would not only recreate the habitat, but also serve to partially stabilize the eroding shoreline at Beach Drive.

Treated effluent discharge from the Charleston facility would be under the same conditions as Alternative 2. At Manchester, the submarine outfall depth would be below 50 m [165 ft]. Modeling results indicate that due to the depth and constant currents in the area, at least 100:1 dilution could be provided 84 percent of the time, resulting in excellent first mixing and dilution, and excellent subsequent dispersion and flushing. In terms of water quality, this alternative would cause the least adverse effects over the long-term as compared to the other alternatives. Good circulation within the Manchester area would draw the effluent away from the shore and should not greatly affect Clam Bay or adjacent areas. Water quality in Sinclair Inlet would improve moderately but not significantly due to the reduced flow of treated wastewater impacting the area.

This alternative requires the greatest construction costs due to the extensive pipeline construction and pumping needed for the Manchester facility, and is, therefore, one of the two highest in total project costs.

### Project Costs

The present worth of all costs for each alternative in January 1977 dollars is shown on Table 1. The present worth is a combination of total capital costs less salvage values and the cumulative operation and maintenance (O&M) costs during the project life. Alternative 1, the no-project alternative, has no associated project costs. Alternatives 2 and 3 are the lowest with present worth values of $24-25 milion. Alternatives 4 and 5 are the highest with present worth values of $26-27 million. It should be noted that all alternative present worth costs are within 11 percent of each other.

In Volume II, Part 3 of the facilities plan a more detailed cost estimate was made for Alternative 2 only. Additional facilities, not costed out in the original comparison were added to this detailed analysis. An estimate of the revised present worth for Alternative 2 is $32 million. Due to the method of cost analysis, equivalent increases in total project costs cannot be made for Alternatives 3-5.

## Capital Costs

Project implementation, as presented by the facilities planner, will require physical construction during the period 1978-80. Alternatives 2 - 5 will require 12-18 months of construction some time during this time-frame.

Total Capital costs for construction range from a low of $16,778,000 for Alternative 2 to a high of $19,441,000 for Alternative 5. This analysis assumed 75 percent federal and 15 percent state participation in capital funding, excluding total land and easement costs which are not grant eligible. Total corresponding costs to local participating jurisdictions would range from a low of $1,846,000 (Alternative 2), to a high of $2,914,000 (Alternative 4).

The salvage value for facilities and land ranges from $0 in Alternative 4 to $810,000 in Alternative 5.

## Operation and Maintenance

Each project alternative represents a separate series of annual costs for the operation and maintenance of the treatment plants and transmission pump stations. These costs are the sum of fixed annual charges and increasing variable charges relating to increased flow capacity. Since O&M costs increase over time, the facilities planner has chosen the specific O&M costs for 1990, the median year of the service life of the treatment facilities (1980-2000) as mathematically representative of annual costs. The annual costs range from $628,000 (Alternative 2) to $756,000 (Alternative 5).

## Table 1. PROJECT COSTS-ALL ALTERNATIVES
## ($1,000)

| | Alternative | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Capital Costs | | | | | |
| Total project costs | - | 16,778 | 17,742 | 17,769 | 19,441 |
| Local share of total project costs[a] | - | 1,846 | 1,921 | 2,914 | 2,108 |
| Annual O&M[b] | - | 682 | 628 | 756 | 691 |
| Salvage value of facilities and land | - | 451 | 784 | 0 | 810 |
| Net present worth[c] | - | 24,438 | 24,729 | 26,353 | 27,108 |

[a] Assumes Federal participation of 75 percent and State participation of 15 percent of total project costs

[b] Represents annual O&M charges plus variable costs related to increased future flows. For detailed explanation of costs, see Section III, Alternatives-Project Costs.

[c] Present worth of all costs less salvage value of facilities and land. For detailed explanation, see Section III.

# SECTION II

# SECTION II

# ENVIRONMENTAL SETTING

## PHYSIOGRAPHY

The study area lies on the Kitsap Peninsula in western Washington. The Kitsap Peninsula includes approximately 1,500 $km^2$ [580 sq mi] of land bounded by the Hood Canal on the north and west, and Port Orchard Bay in connection with Puget Sound on the east. A substantial portion of the shoreline is irregularly-shaped with many inlets and coves. Beaches are generally narrow and flat and set off by steep banks and slopes. Extensions of Puget Sound into the peninsula area include Port Madison, Liberty Bay, Port Orchard Bay and Dyes and Sinclair Inlets (Reference 4).

The study area is approximately 260 $km^2$ [100 sq mi] and constitutes over one-third of Kitsap County. Sinclair Inlet occupies approximately 16 $km^2$ [6 sq mi] in the center of the study area and is connected by Port Washington Narrows to Dyes Inlet in the north-central portion. The gross relief of the Kitsap Peninsula is characterized by north to south trending, gently rounded, low ridges which create an undulating upland province. The ridges on the west side of Dyes Inlet are parallel to the shoreline and rise up from the beach with an average slope of 20 percent. The south shoreline of Sinclair Inlet is buttressed by moderate to steep-sloped bluffs with slopes approaching 30 percent. Elevation provinces shown in Figure 3 indicate low-lying areas (less than 60 m [200 ft] elevation) surrounding the shoreline and including Bremerton, Manchester, the Chico Creek drainage off Dyes Inlet, the Gorst Creek drainage at the base of Sinclair Inlet and the Blackjack Creek Valley extending inland from Port Orchard. The remainder of the study area is typically an upland province with elevations greater than 60 m [200 ft]. Mountainous areas over 180 m [600 ft] occur in the western portion of the study area. Two major lakes in the study area are Kitsap Lake and Wildcat Lake, both located west of Dyes Inlet. The populated portions, as well as attendant sewerage treatment facilities, are located on the lowest elevation province. Construction of new facilities and major interbasin pumping of wastewater would generally be confined to this area, as pumping to higher elevations requires greater cost and energy.

## GEOLOGY

### Stratigraphy

Geological formations underlying the study area, as shown on Figure 4, are predominantly of glacial origin and were deposited during

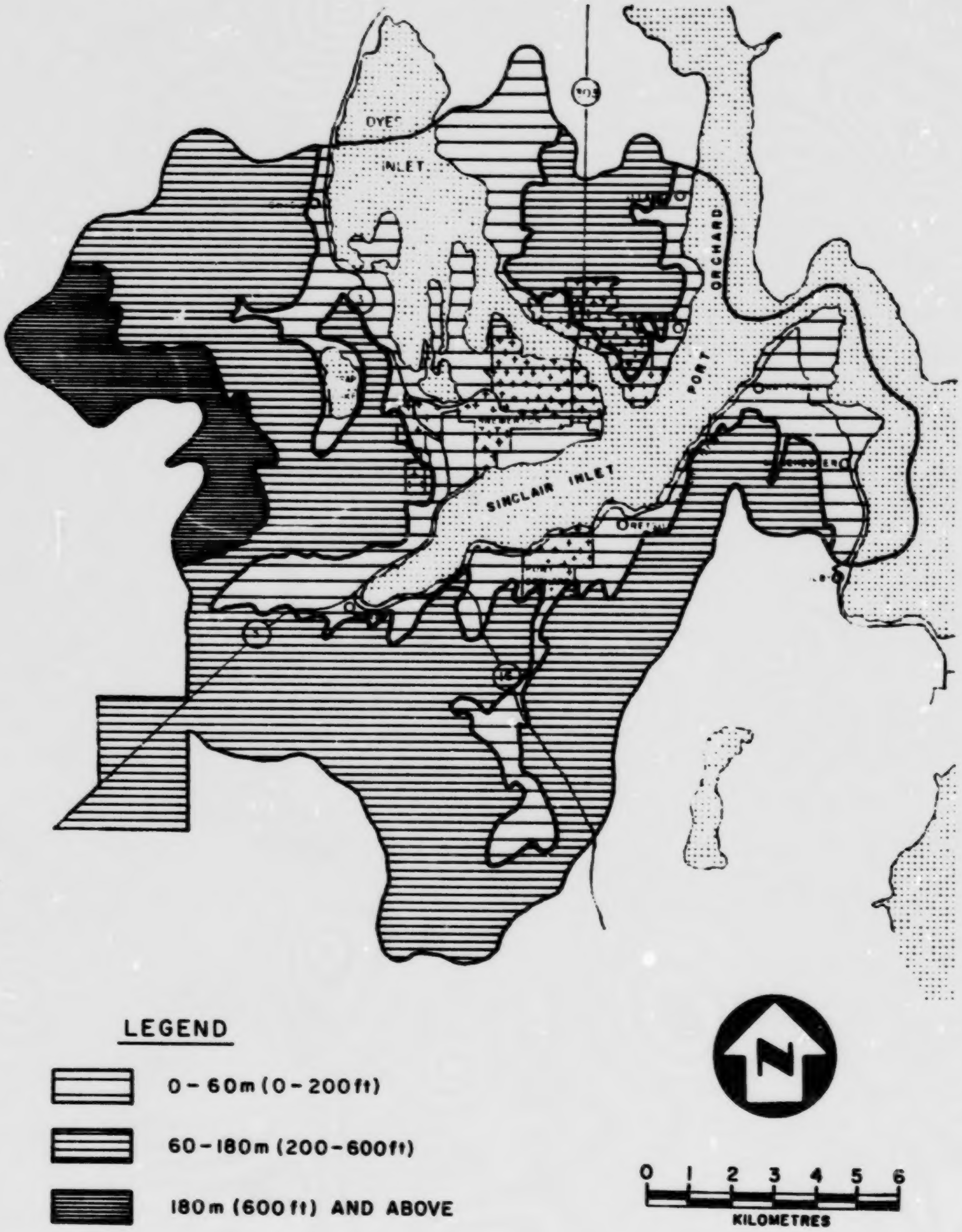
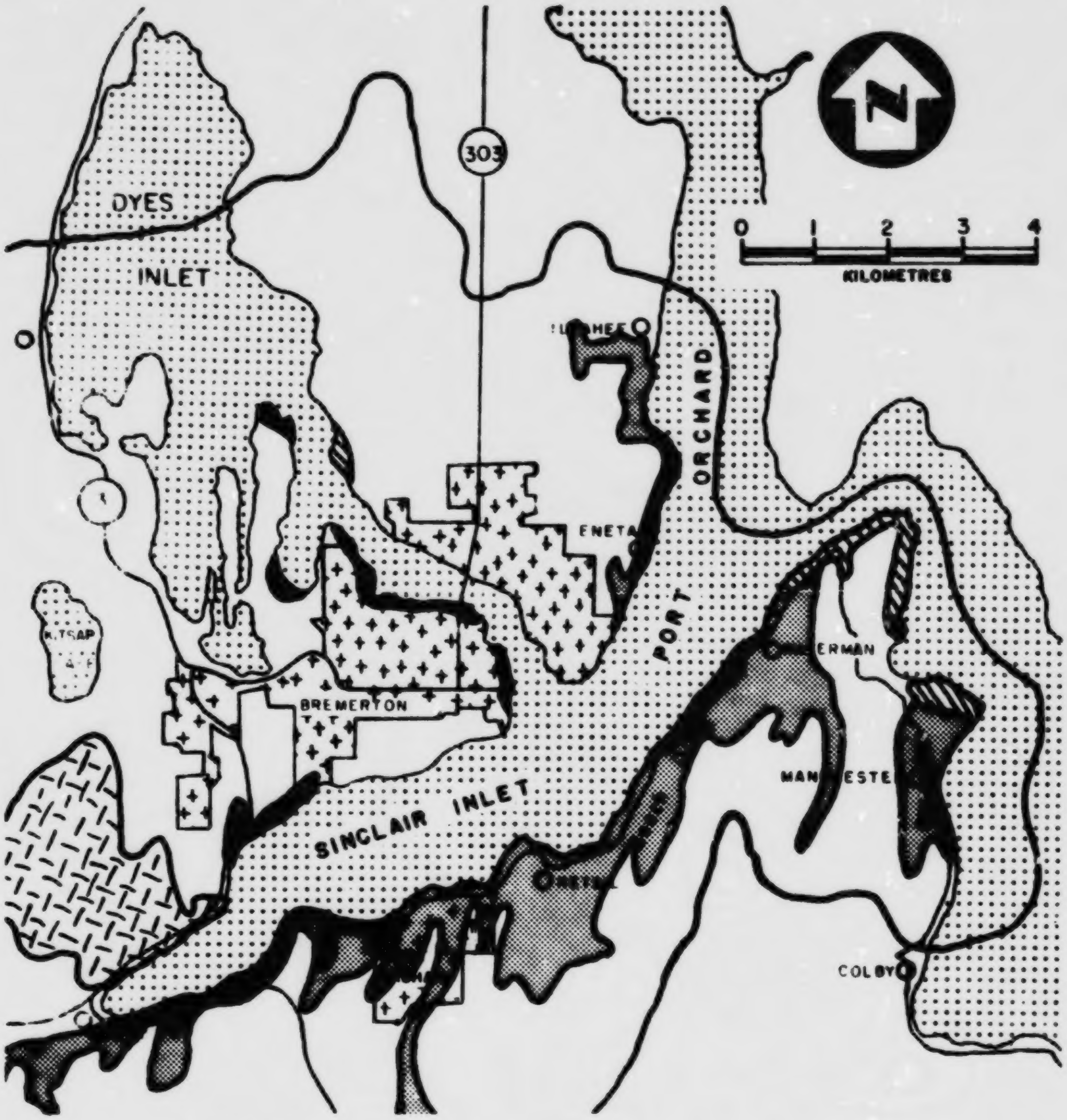

DYES
INLET
PORT
ORCHARD
SINCLAIR INLET
303
16
LEGEND
0 - 60m (0 - 200ft)
60 - 180m (200 - 600ft)
180m (600ft) AND ABOVE
N
0 1 2 3 4 5 6
KILOMETRES

FIGURE 3 ELEVATION PROVINCES OF PLANNING AREA


DYES
INLET
303
0 1 2 3 4
KILOMETRES
ORCHARD
PORT
ENETA
KITSAP
BREMERTON
SINCLAIR INLET
ERMAN
MAN ESTE
COLBY

LEGEND

□ VASHON FORMATION

▒ PUYALLUP FORMATION

■ KITSAP MEMBER OF ORTING FORMATION

▧ BLAKELEY FORMATION

▩ BASALT VOLCANIC

Source: Reference 5

FIGURE 4 GEOLOGIC FORMATIONS WITHIN STUDY AREA (SURFACE EXPOSURE)

the last few million years. Deeper formations, some of volcanic origins from an earlier age (40 - 60 million years), also reach the surface at a few exposures. The glacial deposits have been divided into several formations from most recent to oldest and include the Vashon drift, Puyallup formation, Orting formation and Admiralty drift. Of these, the most dominant exposed geologic formations within the study area are shown on Figure 4.

The uppermost Vashon drift formation generally dominates the surface exposures in the Bremerton - Port Orchard area. The older formations are exposed only along the shoreline and in deep ravines and creek valleys as shown in the schematic geologic structure on Figure 5.

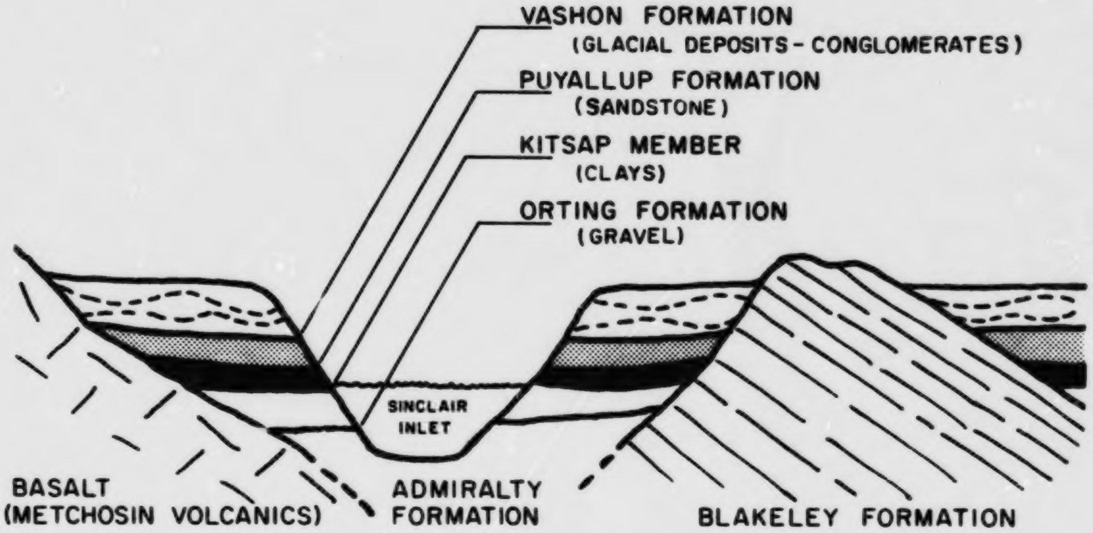

VASHON FORMATION
(GLACIAL DEPOSITS - CONGLOMERATES)
PUYALLUP FORMATION
(SANDSTONE)
KITSAP MEMBER
(CLAYS)
ORTING FORMATION
(GRAVEL)
SINCLAIR INLET
BASALT
(METCHOSIN VOLCANICS)
ADMIRALTY FORMATION
BLAKELEY FORMATION

FIGURE 5 SCHEMATIC GEOLOGICAL CROSS-SECTION ACROSS THE STUDY AREA

## Structural and Tectonic Activity

Studies on the geological structure of the underlying Tertiary sedimentary and volcanic bedrock suggest a monocline, or the flank of an anticline, dipping in a northerly direction under Bainbridge Island (Reference 5). Based upon geophysical and seismic interpretations, an alternative structure portrays the Tertiary bedrock as the exposed remnants on the top of an uplifted fault block or horst, such as appears at South Kitsap High. A fault has been suggested as crossing from west to east, north of East Bremerton, the southern portion of Bainbridge Island and through the Seattle area. This fault has been called the Bremerton-Seattle fault. Other similar east-west faults have been inferred in southern Kitsap County. Such a structure of uplifted blocks would be separated by down-dropped blocks or grabens, such as the Seattle low, which have been filled to present topography by deposition of thick glacial debris.

Tectonic activity in the western Washington area normally does not receive the attention accorded it in states such as Alaska and California, although damaging tremors (6 -7.5 Richter Scale) have and will probably occur in the study area, perhaps during the normal project life of the alternative facilities. Between 1939 and 1965, four damaging tremors occurred within 50 - 100 miles of the study area. During the Puget Sound Earthquake of 1965, Bremerton and Seattle experienced seismic intensity of VII or greater (modified Mercalli Scale). Based upon this tremor and the historic pattern of large and small tremors, the Puget Sound area, including the study area, could receive additional tremors which could result in major damage. Some tremors may result from movements along the inferred faults bounding the Kitsap High and Seattle Low fault blocks near Bremerton.

## Geological Hazards

Land stability hazards commonly consist of landslide and slow-moving slumps, while other aspects of settlement, lurching and liquifaction may also influence portions of the study area. These hazards may occur during an earthquake or under relatively static conditions with high rainfall and water tables. Landslides, slumps and lurching would be of greatest concern along the steep slopes near the Manette Plant, the crossing of Port Washington Narrows, west of Port Orchard and various sites along the shoreline between Port Orchard and Manchester. Additional concern, especially during tremors, should focus on subtidal steep slopes in Sinclair Inlet, especially where water deeper than 20 m [60 ft] passes close to Beach Drive north of Retsil. Lurching may occur where rapid horizontal acceleration during an earthquake dislodges a steep bank, either above or below sea level. As an example, 0.8 km [0.5 mi] of a 100 m [300 ft] high cliff was dislodged into Puget Sound near Tacoma during the 1949 Earthquake of Olympia, Washington. Settlement and liquifaction may occur on filled land where a high water table exists. Such areas exist along the Port Orchard to Retsil area and parts of the south Bremerton area. Several large settlements occurred north of the study area during the 1946 Georgia Strait Earthquake.

## SOILS

The soils of the project area originate from complex glacial deposits which have weathered under the influence of different exposures, water regimes and land use. General classifications can be divided into exposed bedrock, developed soils with hardpan or dense subsoils and developed soils without dense subsoils. The latter two classes are of concern where high water tables and waterlogged soils may affect septic tank usage or agricultural and timber production.

Within the study area, the dominant soils are those of the Alderwood and Everett groups. The Edmonds, Indianola, Kitsap and Melbourne soils also occur in the study area but usually are less common. North of Point Washington Narrows, three types of Alderwood and two types of Everett soils dominate lesser occurrences of the Kitsap and Indianola soils. The Bremerton area is largely underlain by Alderwood soils which are gradually replaced by Everett soils towards the west. Fringes of Indianola and Sinclair soils occur along the shorelines and stream valleys. Southwest of Bremerton, the rocky hill lands of the Blue Hills have little-developed soils, except along the stream valleys which are usually Alderwood or Everett soils. Between Gorst and Port Orchard and to the south, large expanses of both Alderwood and Everett soils dominate scattered occurrences of other soils. The Everett soils tend to increase in the area to the south. Along Ross Creek and several small valleys south of Port Orchard, large swaths of Kitsap loam soils lie along the creek valleys (References 6, 7, 8).

The distribution and composition of the soils across the study area generally reflect the changes of geological formation beneath the surface. Dense clay subsoils or clay lenses in the underlying geological formations have adversely affected septic tank filter field operations tnrough the county. The basalt bedrock between Gorst and Bremerton and the Blakely formation along Rich Passage reduce infiltration and cause perched groundwater tables. Portions of the Vashon formation (compacted glacial tills) and many overlying soils also have very low infiltration rates and cause ponding and perching of surficial water tables. Generally, the Alderwood, Edmonds and Sinclair soils possess dense subsoils and result in filter field failures. Everett, Indianola and Kitsap soils usually do not have dense subsoils, although the perched groundwater table may enter into the soil areas and cause them to become waterlogged.

Soils hazards include relatively simple aspects of erosion of channels, shorelines and general soil surfaces, more involved features of land stability and the most damaging and unpredictable effects of tremors. Erosion in the study area generally involves severe creek bank erosion caused by increasing storm runoff from new urban and industrial development. Along Sinclair Inlet and Rich Passage, wind and ship waves have produced shoreline erosion, especially of artificial fills such as those along Beach Drive between Retsil and Waterman. Such shore erosion is closely related to the soft character of the glacial deposits along the shore south of Point Light (Waterman); further north, the harder bedrock of the Blakeley formation withstands the erosive forces more easily than the glacial deposits. Eroded sediments can also clog creeks and drainage channels; such clogging reduces the channel capacity and causes streams to flood more easily than in the well-scoured creek channel. These erosional effects are apparent in and along several creeks between Port Orchard and Manchester where new urban expansion and conversion has altered runoff and erosional balances.

## CLIMATE

The climate of the Puget Sound Region is controlled largely by air movement from the Pacific and by major landforms. The Olympic Mountains to the west and the mountains of Vancouver Island to the north effectively protect the region from the full intensity of winter storms reaching the coast. On the other hand, the Strait of Juan de Fuca, north of the Olympic Mountains, the Chehalis Valley to the southeast and adjacent lowlands provide passages for marine air moving inland. The Cascade Range usually shields western Washington from continental air masses and their temperature extremes. These enclosing mountains, however, may have negative effects as they induce air mass stagnation over the lowlands (Reference 9).

The Kitsap Peninsula shares Puget Sound's characteristically maritime climate, typified by relatively short, cool, dry summers and prolonged mild, wet winters. During summer, few major storm disturbances penetrate into the Puget Sound area. Precipitation during this period is generally limited to isolated shower activity, and clear, sunny days usually prevail. In winter, most of the study area south of Dyes Inlet is generally well-watered because of the influence of air flow through the gap between the Olympic Mountains and the Black Hills (Reference 10).

## Precipitation, Humidity and Evaporation

Precipitation patterns in the study area are characterized by frequent rainfalls of low intensity. The mean annual precipitation distribution in central Kitsap County is shown in Figure 6. The mean precipitation within the study area varies from a low of 114 cm [45 in] to a high of 167 cm [66 in] per year. Average monthly precipitation for Bremerton is portrayed in Figure 7. Approximately 85 percent of the precipitation occurs between October and April. Precipitation in the form of snowfall is generally light, and the depth on the ground in the lower elevations seldom exceeds 8 to 15 cm [3 to 6 in] (Reference 1).

The relative humidity ranges from 75 to 85 percent in the winter, and in the summer from 40 to 50 percent in the afternoon to 85 percent at night (Reference 1).

Annual evaporation as measured by a Class A pan in the region is estimated at 64 to 89 cm [25 to 35 in]. Annual water loss by evaporation from lakes and reservoirs is estimated at 51 to 64 cm [20 to 25 in] (Reference 1). The seasonal soil moisture water deficit due to evapotranspiration occurs between May and October.

## Temperature

The monthly mean temperature at Bremerton during 1974 was 11°C [51 °F], while the range was from -7 to 33°C [20 to 91°F]. Temperatures above 38°C [100°F] or under -18°C [0°F] seldom occur. Summer daytime temperatures average 21° to 26°C [70° to 80°F], dropping to 4° to 10°C [40° to 50°F] at night. Maximum daytime temperatures occur from July through September. Winter temperatures average 4° to 10°C [40° to 50°F] during the day, and -1° to 4° C [30° to 40°F] at night. The minimum annual nighttime temperatures occur during December and January. Extremely cold temperatures in the Puget Sound region are usually caused by outbreaks of cold polar air from central British Columbia. Most of the lighter frosts, however, result from ground heat losses on calm, clear nights. Average frost-free periods, or growing seasons, range from approximately 225 to 260 days per year (References 1, 4 and 9).

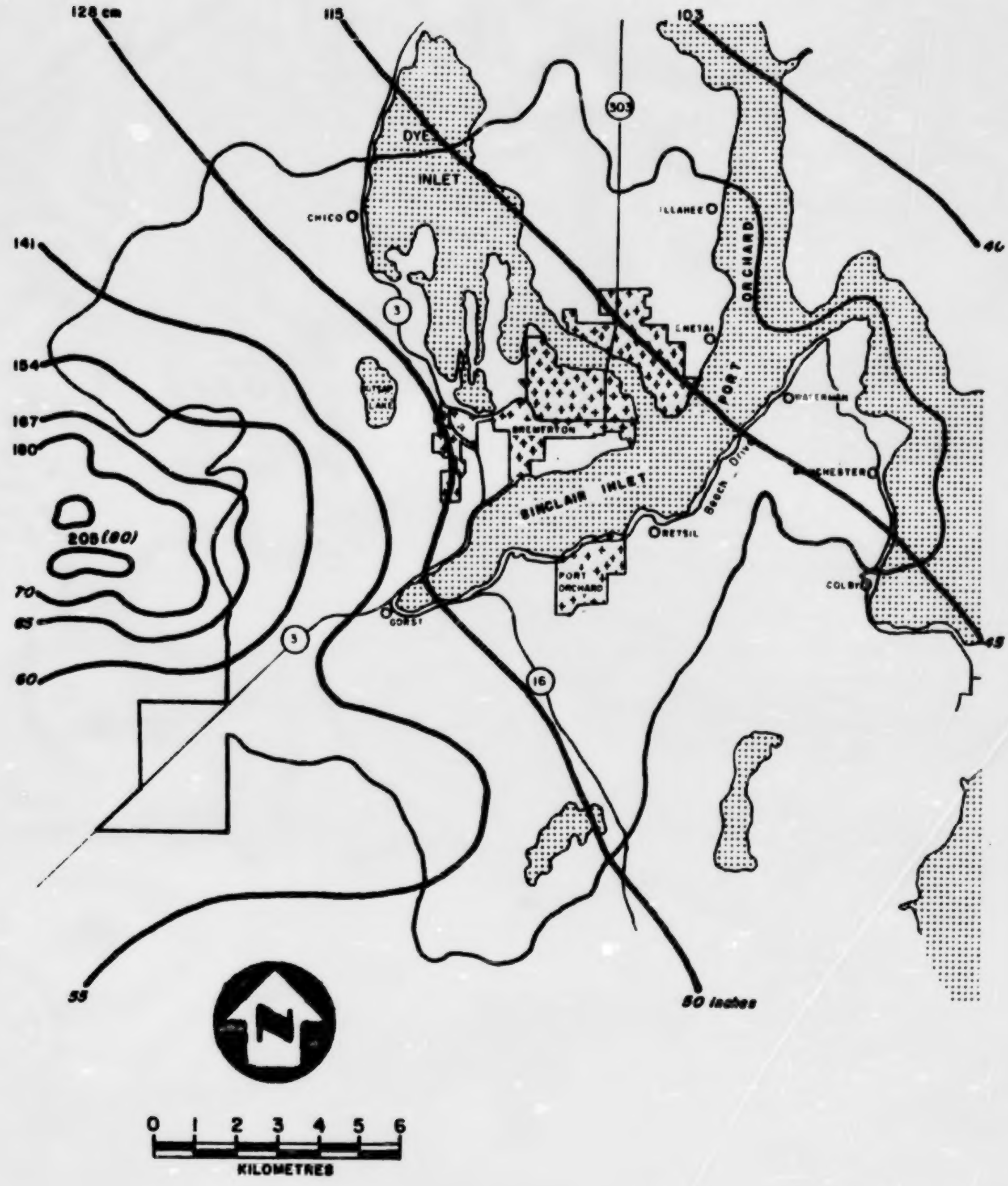
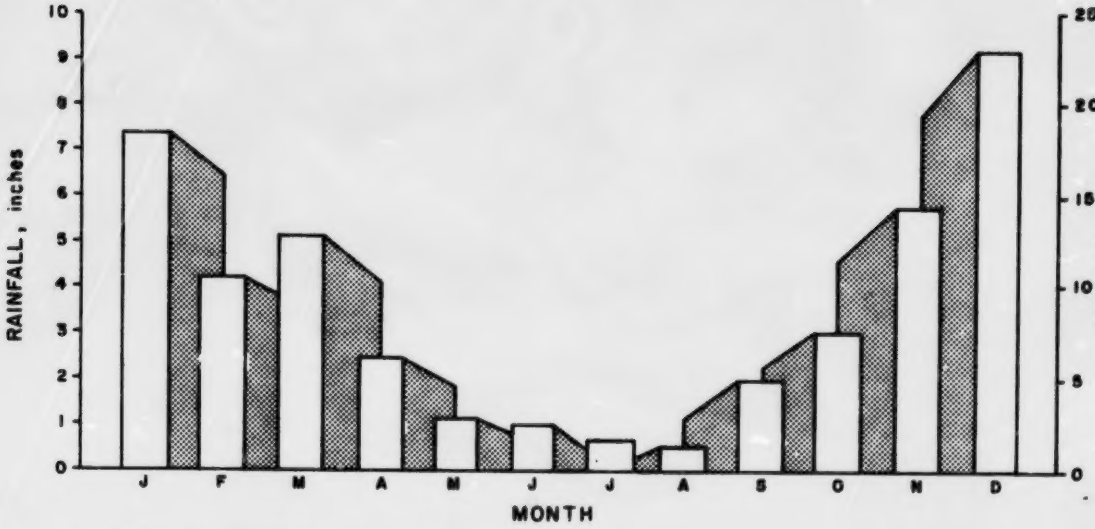

128 cm
115
103
40
141
154
167
180
205 (80)
70
65
60
55
50 inches
45
DYES
INLET
CHICO
ILLAHEE
PORT
ORCHARD
303
3
KITSAP
LAKE
BREMERTON
SINCLAIR INLET
RETSIL
Beach Drive
WATERMAN
MANCHESTER
COLBY
GORST
PORT
ORCHARD
16
N
0 1 2 3 4 5 6
KILOMETRES

FIGURE 6 MEAN ANNUAL PRECIPITATION
KITSAP COUNTY
(1946 - 1960)



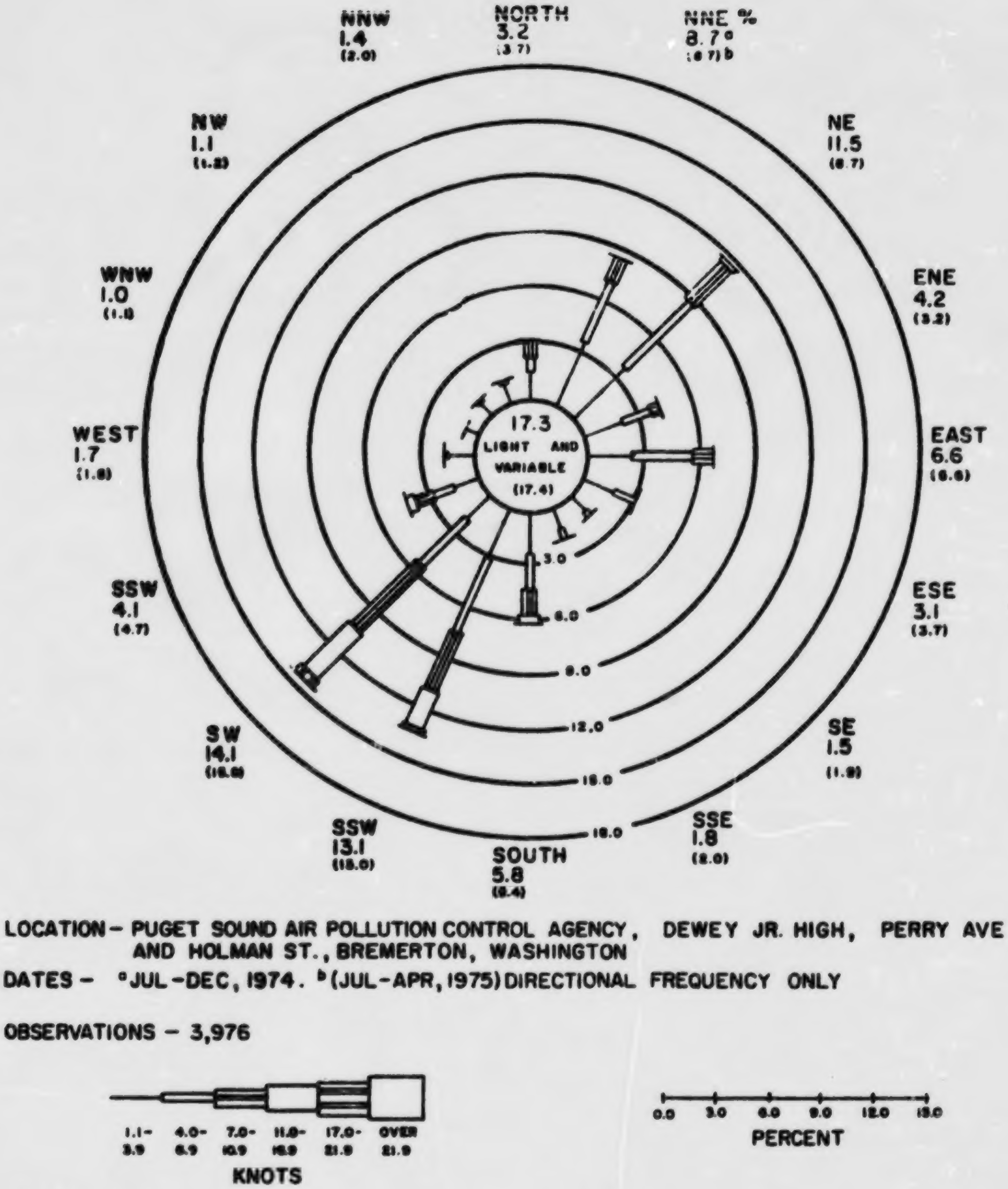
SOURCE: REFERENCE I

FIGURE 7 : AVERAGE MONTHLY PRECIPITATION FOR THE TEN YEAR PERIOD 1965 - 1974, BREMERTON GAGING STATION

## Winds

Within the general Puget Sound region, the fall and winter are characterized by southwesterly prevailing winds, while those in the spring and summer are from the northwest.

Wind sampling in the vicinity of the study area was initiated in East Bremerton during July 1974 by the Puget Sound Air Pollution Control Agency. A wind rose for July 1974 through December 1975 is presented in Figure 8. The spokes indicate the relative frequency of winds of different speeds. The number below the directional signs on the perimeter of the wind rose indicate the percentage frequency of winds blowing from that direction. The first number is for six months of data and the second number, in parentheses, relates to ten months of data.



LOCATION - PUGET SOUND AIR POLLUTION CONTROL AGENCY, DEWEY JR. HIGH, PERRY AVE AND HOLMAN ST., BREMERTON, WASHINGTON

DATES - aJUL-DEC, 1974. b(JUL-APR, 1975) DIRECTIONAL FREQUENCY ONLY

OBSERVATIONS - 3,976

Source: Reference 3.

Figure 8. PERCENTAGE FREQUENCY OF OCCURRENCE OF HOURLY AVERAGE SURFACE WINDS.

## AIR QUALITY

Air temperature inversions, which can intensify air pollution problems, are prevalent in the Puget Sound basin, largely because of the enclosed mountain basin setting noted earlier. Temperature inversions are most likely to occur during early spring and again in late summer and early fall. Data collected on inversions during each month of 1972 revealed that they were most frequent during October. Temperature inversions seldom prevail more than a few days before they are displaced by a new weather system moving into the region (Reference 9).

Air quality is determined by the presence of many inert and chemically active substances such as carbon monoxide, oxides of nitrogen, hydrocarbons, suspended particulates, photochemical oxidants and sulfur dioxide, as well as meteorological conditions such as temperature gradients and wind speed.

### Existing Conditions from Available Inventory Data

Pollutant emission rates appropriate for the study area have been estimated and are summarized in Table 2 for 1975 conditions. Countywide estimates were provided by the Puget Sound Air Pollution Control Agency which summarized the following categories of the 1972 Kitsap County air contaminant emissions: fuel combustion, industrial sources, solid waste disposal, transportation sources and miscellaneous area sources such as orchard heating, agricultural burning and slash burning. These data were updated to 1975 assuming that only transportation and residential area sources of fuel were population dependent. Current solid waste disposal and slash burning are also updated in accordance with population estimates. Monitoring of pollutant levels by the Puget Sound Air Pollution Control Agency at stations in Bremerton, Seattle, Tacoma and on Maury Island indicates that Kitsap County has generally good to excellent air quality throughout the year. The levels for 1975, although slightly higher than those taken in 1974, were still well below the annual standard in each pollutant category (Reference 10).

Table 2. AIR POLLUTANT EMISSIONS IN KITSAP COUNTY (1975)

| Carbon monoxide | | Hydro-carbons | | Nitrogen oxides | | Sulfur dioxide | | Particulates | |
|---|---|---|---|---|---|---|---|---|---|
| A[a] | B[b] | A | B | A | B | A | B | A | B |
| 64.00 | 0.50 | 15.14 | 0.12 | 6.97 | 0.06 | 4.70 | 0.04 | 2.33 | 0.02 |

[a] Metric tons per day, (1 metric ton -0.91 ton)

[b] Kg per person per day, (1 kg - 2.2 lbs).

A specially commissioned monitoring program was conducted during the spring of 1975 (Reference 11) in Bremerton, a location assumed to be highest in pollutant levels because of its greater population. The program has shown that carbon dioxide levels are far below one-hour and eight-hour standards. It is assumed that corollative, typical smog constituents were also present at similarly low levels. The low pollutant levels are generally attributed to few pollutant sources within the county and frequent winds which mix and dilute any existing aerial emissions (Reference 4).

## NOISE

Data describing present noise conditions are limited. In general, Kitsap County is quiet and rural in nature. Most noise levels which cause the majority of long-term disturbances occur along major arterial roads as a result of traffic. Areas with a relatively higher degree of urban noise include the cities of Bremerton and Port Orchard and the Puget Sound Naval Shipyard. Most of the existing wastewater treatment plants are located in areas of higher noise levels near residential development. However, the existing treatment plant's noise levels are low enough to be completely masked by daytime ambient noise levels. No observations were made of nighttime conditions.

## ODORS

The study area is free of widespread odor-producing sources. Within the County, there are probably two main characteristic types of localized odors. The first is associated with agricultural practices where livestock and fertilizer applications produce odors typical of a farm environment. The second type of odor is that associated with mud flats along the shorelines and is most noticeable when the intertidal areas are exposed during low tide. When oxygen in the sediments is low and organic content high, characteristic sulfide and decomposition odors may be emitted. Other odors of smaller significance, are those normally associated with urban development, commercial activities and the nearby Puget Sound Naval Shipyard.

## FRESHWATER HYDROLOGY AND WATER QUALITY

### Surface Water

The study area is drained by many small streams of which the majority have relatively small drainage areas and flow directly into marine waters. These streams form five drainage sub-basins which comprise Water Resource Inventory Area 15 (WRIA 15) and are shown in Figure 9. A summary of the drainage areas and flows is presented in Table 3. Most of the study area is drained by three major creek systems: Chico, Gorst and Blackjack Creeks. Gorst and Blackjack creeks maintain a sizeable base flow year around from groundwater discharges. However, many portions of the study area are geologically and topographically unsuited for storing appreciable amounts of groundwater. As a result, streams tend to recede rapidly after a storm and little water is retained in the groundwater reservoir to maintain base flow during dry periods. Thus, the majority of the creeks follow a seasonal pattern of high flows in the winter and low flows in the summer, with transition periods occurring in the spring and fall. Peak stream discharges usually occur during the months of November through February (Reference 12).

There are approximately 30 lakes and reservoirs in the study area. The greatest majority are shallow and average 1.6 ha [4 ac] in size. The primary use of these lakes is for recreation, although a few are classified for public water supply, including Heins, Jarstad and Alexander lakes and Hunts Mill pond. Kitsap Lake and Wildcat Lake are by far the largest lakes in the study area at 96 and 46 ha [238 and 113 ac] in area, respectively.

### Water Supply and Water Rights

The existing streamflows and shallow groundwater aquifers in WRIA 15 presently meet the water supply demands of the study area. With projected local growth related to the Trident project and the

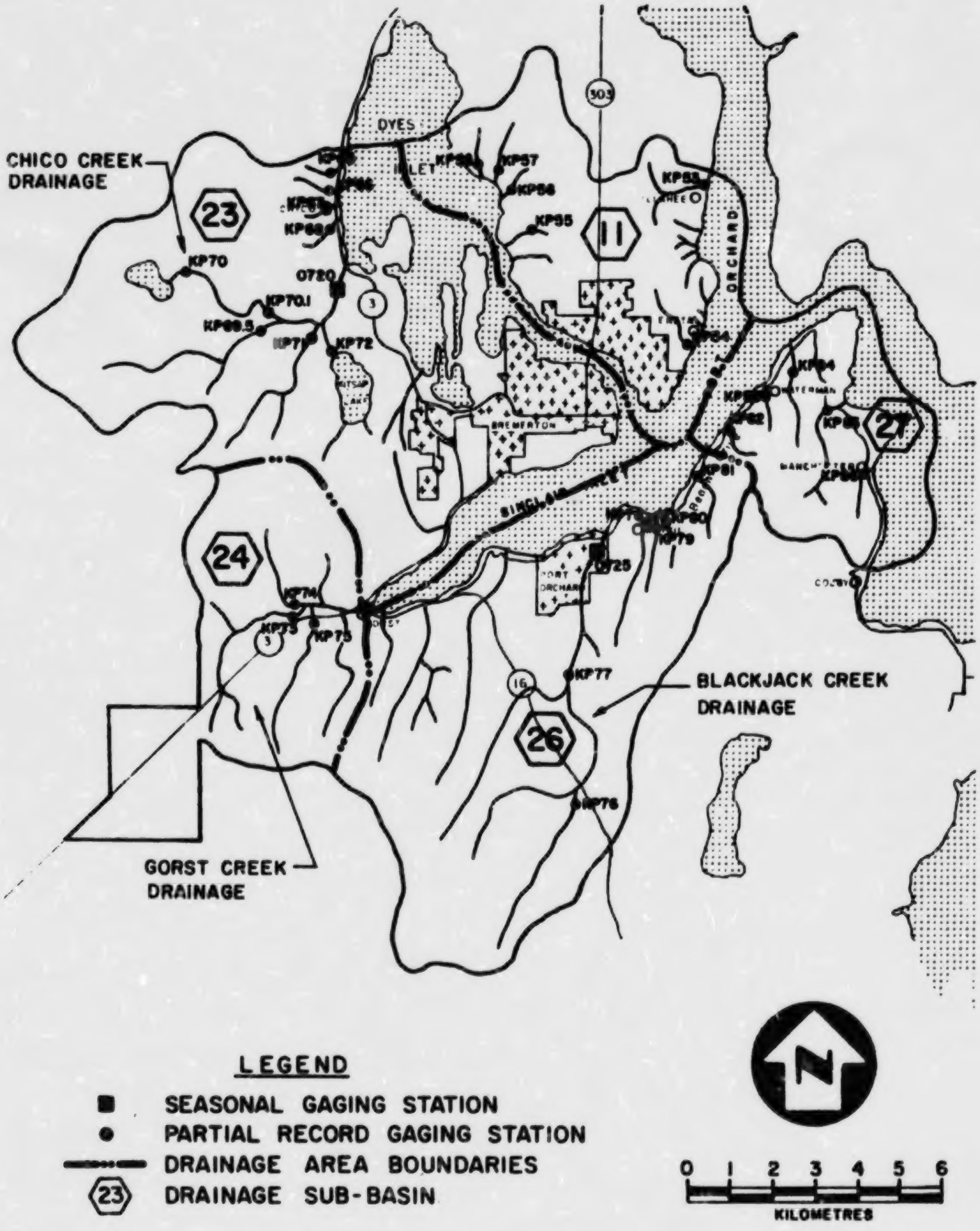

CHICO CREEK DRAINAGE
23
11
24
26
27
DYES
INLET
303
3
16
ORCHARD
BREMERTON
SINCLAIR INLET
PORT ORCHARD
GORST
COLBY
KP70
KP70.1
KP69.5
KP71
KP72
0720
KP73
KP74
KP75
KP76
KP77
0725
KP55
KP56
KP57
KP63
KP64
KP79
KP80
KP81
KP82
KP84
BLACKJACK CREEK DRAINAGE
GORST CREEK DRAINAGE
LEGEND
■ SEASONAL GAGING STATION
● PARTIAL RECORD GAGING STATION
DRAINAGE AREA BOUNDARIES
23 DRAINAGE SUB-BASIN
N
0 1 2 3 4 5 6
KILOMETRES

FIGURE 9 LOCATION OF PRINCIPAL STREAMS AND DRAINAGE AREAS

## Table 3

## DRAINAGE AREAS AND LOW FLOW CHARACTERISTICS

| Gaging station number[a] | Stream | Drainage area km$^2$ [b] | Minimum discharge | |
|---|---|---|---|---|
| | | | ℓ/s[c] | Date |
| | **Drainage sub-basin 11** | | | |
| KP53 | Illahee Creek | 3.32 | 11.67 | 8/27/47 |
| KP54 | Unnamed trib. to Port Orchard | 1.81 | 7.40 | 8/27/47 |
| KP55 | Unnamed trib. to Dyes Inlet | 0.54 | 1.42 | 8/22/58 |
| KP56 | Mosher Creek | 4.09 | 7.97 | 8/26/47 |
| KP57 | Unnamed trib. to Dyes Inlet | 1.09 | 0 | 8/25/47 |
| KP58 | Unnamed trib. to Dyes Inlet | 0.70 | 0 | 8/26/47 |
| | **Drainage sub-basin 23** | | | |
| KP65 | Woods Creek | 1.04 | 5.69 | 8/22/58 |
| KP66 | Unnamed trib. to Dyes Inlet | 0.44 | 2.28 | 9/25/47 |
| KP67 | Unnamed trib. to Dyes Inlet | 0.13 | 2.28 | 9/25/47 |
| KP68 | Unnamed trib. to Dyes Inlet | 0.60 | 1.71 | 8/22/58 |
| 0720 | Chico Creek Drainage | (43.26) | | |
| KP70 | Wildcat Creek | 6.48 | 3.98 | 9/08/61 |
| KP70.1 | Wildcat Creek | 16.06 | 20.77 | 9/08/61 |
| KP70.2 | Lost Creek | 7.98 | 20.77 | 9/08/61 |
| KP71 | Dickenson Creek | 5.67 | 1.14 | 8/05/47 |
| KP72 | Kitsap Creek | 7.07 | 2.28 | 8/21/58 |
| | **Drainage sub-basin 24** | | | |
| | Gorst Creek Drainage | (19.76) | | |
| KP73 | Gorst Creek | 11.24 | 218.50 | 8/28/47 |
| KP74 | Heins Creek | 4.22 | 17.64 | 8/19/58 |
| KP75 | Parish Creek | 4.30 | 23.05 | 8/28/47 |
| | **Drainage sub-basin 26** | | | |
| 0725 | Blackjack Creek Drainage | (30.85) | | |
| KP76 | Blackjack Creek | 3.65 | 102.71 | 8/15/58 |
| KP77 | Blackjack Creek | 27.20 | 135.14 | 8/28/47 |
| KP78 | Annapolis Creek | 4.82 | 11.38 | 8/27/47 |
| KP79 | Unnamed trib. to Port Orchard | 0.52 | 11.38 | 8/21/58 |
| KP80 | Unnamed trib. to Port Orchard | 0.18 | 4.84 | 8/21/58 |
| KP81 | Sullivan Creek | 2.59 | 10.24 | 8/21/58 |
| | **Drainage sub-basin 27** | | | |
| KP82 | Unnamed trib. to Port Orchard | 0.65 | 0.57 | 8/21/58 |
| KP83 | Unnamed trib. to Port Orchard | 0.83 | 0 | 8/21/58 |
| KP84 | Unnamed trib. to Port Orchard | 1.04 | 1.71 | 8/27/47 |
| KP85 | Beaver Creek | 4.17 | 12.52 | 8/27/47 |
| KP86 | Duncan Creek | 1.17 | 1.14 | 8/27/47 |

[a] For location of gaging stations, see Figure 9.

[b] 1 km$^2$ = 0.39 sq mi.

[c] 1 liter/second (ℓ/s) = 0.035 cubic feet/second (cfs)

expansion of the Puget Sound Naval Shipyard, water supply will not be adequate to meet future demands. The Bremerton area will probably be the first to face a serious water shortage as this area contains the most concentrated population and highest water demands. Other areas supplied by stream diversions may also be subject to water shortages. Several major surface water sources have been closed to further appropriation.

Table 4 shows water rights and minimum flow characteristics for two major water sources. Low flow in Blackjack Creek is probably adequate to meet the demands of water rights holders. However, the waters of Chico Creek may have been appropriated beyond its low flow volume. This "over-appropriation" may not be of significance during normal rainfall years due to relatively higher flow volumes and subsequent usage by downstream water rights holders. But during abnormally dry years such as 1976 and 1977, it may have serious consequences for both available water supply and water quality parameters.

Table 4. APPROPRIATED WATER RIGHTS VERSUS LOW FLOWS IN BLACKJACK AND CHICO CREEKS

| Creek Name | Total appropriated quantity, ℓ/s[a] | Low flow characteristics,[b] ℓ/s |
|---|---|---|
| Blackjack | 111 | 136 |
| Chico | 625 | 477 |

[a] (1 ℓ/s = 0.035 cfs)

[b] From Table 2.

Source: Reference 12.

## Surface Water Quality

In accordance with the State of Washington water quality standards, all streams which feed into lake systems have been classified AA (Extraordinary) and all other surface waters have been classified A (Excellent). A special "lake" classification has been established for lakes and impoundments. A summary of these classifications and their criteria is presented in Appendix A.

Water quality sampling for selected waters in the study area has been conducted by DOE, the U.S. Geologic Survey (U.S.G.S.) and the Bremerton-Kitsap County Department of Public Health (Reference 1).

Water quality of streams in Kitsap County is generally considered suitable for most purposes throughout much of the year, with the exception of those waters in and immediately below heavily urbanized areas. Water quality of the county's lakes is also generally satisfactory for most uses, including domestic water (Reference 10).

The Bureau of Sport Fisheries and Wildlife have reported that past logging activities in some areas of the Kitsap Peninsula have damaged fishery resources through slash dumping, yarding through streams, clear-cutting streambanks, roadbuilding and improper road and culvert construction. Logging on small, scattered tracts is a significant activity in Kitsap County, though not to a great extent within the study area (Reference 12). While the extent of agricultural activities on the Kitsap Peninsula is not great, local conditions may present water quality problems. There are no significant agricultural water pollution sources within the study area.

The lakes and streams of the study area are similar in chemical character to the region's groundwater. Calcium, magnesium, bicarbonate and silica are the principal dissolved mineral constituents. Surface water, however, generally contains less dissolved material than groundwater, especially during periods of high surface runoff. With few exceptions, the dissolved solids contents of surface water are less than 100 ppm, even during periods of low flow (Reference 12). Small streams and lakes often exhibit brown water coloration during the high flow period due to organic solutes derived from swamps and poorly drained marshy areas.

Ongoing sampling conducted from January 1974 by the Kitsap County Health Department for several streams and lakes indicates that most fresh water in the study area meets DOE classification standards for class A, AA and Lakewaters. However, total coliform levels have exceeded standards more than once in the following streams and lakes (References 1 and 12).

| Streams | Lakes |
|---|---|
| Blackjack Creek | Kitsap Lake |
| Chico Creek | Wildcat Lake |
| Gorst Creek | Deep Lake |

The high coliform counts have been largely attributed to widespread septic tank failure in the region (Reference 1). The presence of coliform bacteria is an indication that disease-causing organisms may be present in the tested waters.

## Groundwater

### The Groundwater System

The complexity of the glacial materials found underlying most of Kitsap Peninsula makes it difficult to determine the exact location and extent of porous geologic formations, but there is evidence that many are continuous beneath several local watersheds, as illustrated in Figure 4. In some cases, the direction of groundwater movement is independent of surface topography, and, under such conditions, some of the precipitation received in one watershed could be transferred as groundwater to adjacent watersheds. If stream channels in the adjacent areas intercept such groundwater, some of the water will eventually be discharged into their surface water systems (Reference 12).

Well hydrographs in the study area have indicated that groundwater in storage, including that in deep, water-bearing strata, is closely related to the amount of annual precipitation (Reference 13). Shallow groundwater or seasonal groundwater tables, which are generally found at low elevations or adjacent to streams, rise to their highest level within a month following peak precipitation - normally in early winter. The shallow groundwater levels recede rapidly following the decline of rainfall. The lowest water levels, or periods of depletion, occur in late summer.

High seasonal groundwater, 0.6 to 1.2 m [2 to 4 ft] below the ground surface, occurs in approximately 20 different soil types distributed throughout the area. This is especially the case in the Bremerton area, where soils are underlain by consolidated till, and in the Port Orchard/Retsil area, where soils are predominantly loam or silt loam (Reference 1).

Groundwater for domestic purposes is available in nearly all parts of Kitsap County. In many places, particularly in the western portion of the peninsula, shallow wells have been dug to obtain perched groundwater from the till or outwash materials which overlie the relatively impermeable Vashon till (Reference 14). Several large capacity wells have been drilled in the Bremerton/Port Orchard area, taking advantage of both the relatively high seasonal water table and deeper confined groundwater. Generally, water-bearing strata are found within 30 m [100 ft] of the land surface, as evidenced by water levels in wells throughout the county, particularly in the central portion (References 1, 12 and 13).

## Groundwater Quality

In general, groundwater in the study area appears to be of good chemical quality (Reference 1). According to State standards, groundwater quality problems are confined primarily to isolated instances of high iron and high chloride concentrations. Little correlation exists between geologic formation and iron concentration, although the higher concentrations are found in water from formations below Colvos sand. Instances of high chloride concentrations, an indication of salt water intrusion, are confined to areas of the peninsula and adjacent islands outside of the study area at the present time (References 1 and 12).

Other chemicals of minor significance found in the region's groundwater include fluorides, nitrates and hydrogen sulfide. Fluoride content is extremely low with all analyses for the region showing less than 0.40 ppm. Nitrate concentrations are relatively low and typically found in water from shallow wells that have been affected by septic tank seepage or percolation of polluted surface waters (Reference 12).

Groundwater of the Kitsap Peninsula area is characterized by a low dissolved solids content and moderate water hardness. Increases in dissolved solids, water hardness and silica generally correlate with deeper water-bearing zones in older formations. If future water demand requires the utilization of deeper aquifers, then the increased presence of solids, water hardness and silica are unsuitable for certain industrial uses such as boiler feed, ice production or paper production.

## TERRESTRIAL ENVIRONMENT

The Kitsap study area is located within the Western Hemlock Forest Zone, which is characterized as being the most extensive vegetation zone in western Washington and Oregon and the most important in terms of timber production. The Puget Sound area is a sub-unit within the Western Hemlock Zone and contains slight differences in vegetation distribution and dominance, as related to localized climate and soil factors (Reference 15). The area lies in the rain shadow of the Olympic Mountains, receiving 114-167 cm [45-66 in.] annual precipitation, with at least 85 percent of the precipitation falling between October and April. This greater amount of moisture over the winter and spring months plays an important role in the distribution and abundance of local vegetation.

## Biotic Communities

Conifers originally covered almost the entire study area. Since western settlement commencing in the 19th Century, the vegetation has been altered by successive land use changes. The present biotic communities, which are characterized by the dominant vegetation type, consist of: (1) Woodland Forest, (2) Pasture/Meadow, (3) Freshwater Marsh, (4) Residential and (5) Marine Shoreline. The Woodland Forest can be sub-divided into Coniferous Forest, Broadleaf Forest and Mixed Coniferous Broadleaf Forest. There is considerable intergrading of species within these units, and they should not be viewed as distinct entities. The distribution of these units is largely a function of climate, relief, substrate and the occurrence of fire, grazing, logging and other human activities. The Woodland Forest is the predominant unit with the maritime climate being favorable to the growth of conifers. Broadleaf forests are limited in distribution and occur most frequently in recently disturbed areas, specialized habitats such as riparian zones or in marginal areas unsuitable for conifers (Reference 16). Examples of the five biotic communities within the study area are shown on Figure 10 and are described in Appendix B. The characteristic vegetation and wildlife of each community is presented in Appendix B-1. Species lists of vegetation and wildlife probably occurring within the biotic communities are given in Appendices B-2, B-3, B-4 and B-5.

## Rare and Endangered Species

No rare or endangered plant species are found within the planning area (Reference 17). The American peregrine falcon *(Falco peregrinus anatum)* is the only wildlife species considered to be endangered within the study area (Reference 18). Due to urbanization, forest clearing and other changes in land use, this bird is probably transient and does not depend on specific parts of the study area as a permanent or primary habitat. Outlying regions beyond the study area which are less disturbed and closer to their natural habitat may attract and support a small peregrine falcon population.

No endangered mammalian species are recognized within the study area (Reference 19); however, several rare species which may exist in the study area have been identified by the Washington State Game Department. These are the mountain lion *(Felis concolor)*, sea otter *(Enhydra lutris)*, fisher *(Martes pennanti)* and western gray squirrel *(Sciurus griseus)*. The Game Department definition of rare is: "A rare species or subspecies...that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if the environment worsens" (Reference 19).

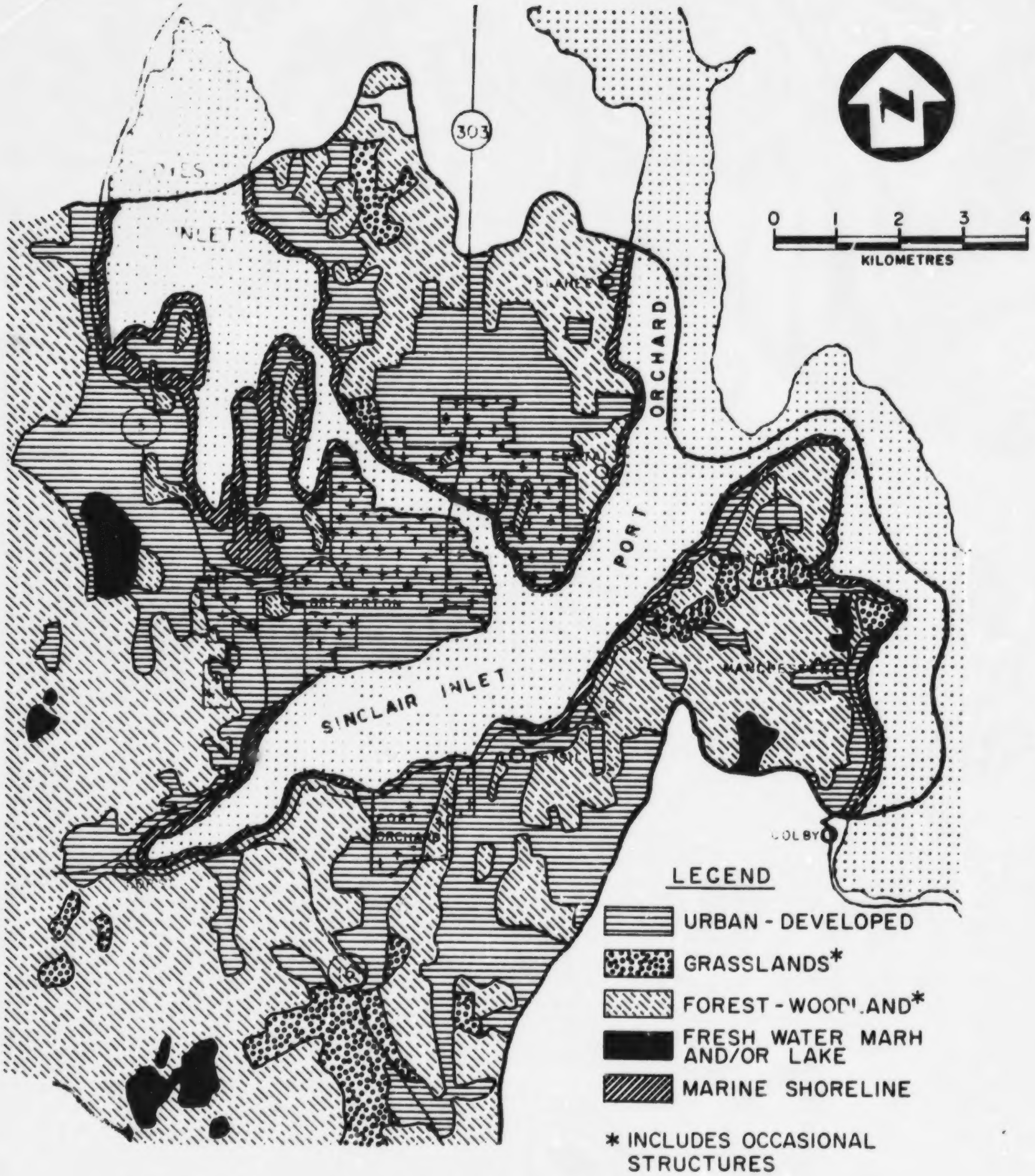

303
INLET
0 1 2 3 4
KILOMETRES
PORT ORCHARD
BREMERTON
SINCLAIR INLET
PORT ORCHARD
MANCHESTER
COLBY
LEGEND
URBAN - DEVELOPED
GRASSLANDS*
FOREST - WOODLAND*
FRESH WATER MARH AND/OR LAKE
MARINE SHORELINE
* INCLUDES OCCASIONAL STRUCTURES

FIGURE 10 GENERAL VEGETATION AND LAND USE DISTRIBUTION IN CENTRAL PORTION OF STUDY AREA

### Sensitive Ecological Areas

Human settlement has greatly changed the local ecology of the Kitsap area through alterations in land use and the introduction of non-native vegetation and animals. Urbanization has removed some wildlife habitat areas from the region. Most areas retain their original vegetation community characteristics except for the second-growth characteristics shown in forested areas.

Within the Kitsap planning area, sensitive ecological areas are generally associated with watercourses and water bodies. Stream systems provide valuable wildlife habitat. Alteration of streambeds occurs mainly near populated areas and has not greatly reduced habitat along more remote stream sections. One of the most serious impacts upon streams in the last few decades is the development of roadways and structures across stream mouths as they empty into the Puget Sound system. Obstruction of stream mouths degrades the estuarine zone and can block seasonal upstream migrations of anadromous fishes.

## PHYSICAL MARINE ENVIRONMENT

### Hydrography and Circulation

The study area is surrounded by Puget Sound and its inlets and canals. Puget Sound is connected to the Pacific Ocean by the Strait of Juan de Fuca and Admiralty Inlet, through which most of the Sound's oceanic waters enter. Puget Sound is a deep fjord-like embayment covering approximately 6500 sq km [2,500 sq mi]. Water depths of 180 m [600 ft] are typical in the central basin near Seattle, and maximum depths extend to 280 m [930 ft]. Tidal exchange of Sound waters with incoming ocean waters varies with depth and density characteristics. Theoretically, the entire volume of the Sound's waters is replaced about twice a year. Considerable variation occurs between the extremities and the central basin, however, and flushing efficiency varies widely on a monthly basis.

The shallow sills are critical in controlling the mixing and the nature of the water which contributes to the deep waters in the inner basins of Puget Sound. Mixing by surface cooling during the winter and by flow across sills tends to equalize dissolved oxygen and nutrient salts vertically through the water. Because of this mixing and the tidal exchange that occurs with waters of the open ocean, the water of Puget Sound is well supplied with oxygen and mineral salts necessary to support aquatic ecosystems. Consequently, Puget Sound provides a rich habitat for a diverse community of organisms.

The portion of Puget Sound most affected by the alternative designs under consideration is the Port Orchard subsystem, which includes Sinclair and Dyes Inlets, the Port Washington Narrows and Rich Passage. Puget Sound enters the embayments in the study area through Port Orchard Bay and Rich Passage. Port Orchard Bay is approximately 1.2 km [0.75 mi] wide and 19 km [12 mi] long. Midchannel depths average 27 m [90 ft] at mean lower low water (MLLW). Rich Passage is narrowest at the west end 0.4 km [0.25 mi] and widens to meet Puget Sound at the east end. Depths range from 12 to 30 m [40 to 100 ft] (MLLW). Sinclair Inlet is a shallow bay approximately 1.2 km [0.75 mi] wide and 8 km [5 mi] long. Mean lower low water (MLLW) depth varies from 6 to 7.6 m [20 to 25 ft] at the west end to over 15.2 m [50 ft] at the east end of the inlet. Dyes Inlet is approximately 1.6 km [1 mi] wide and 8 km [5 mi] long. The inlet is deepest at the center, approximately 40 m [130 ft] (MLLW), and shallowest at the north and south ends (MLLW depth of 12 m [40 ft]). Port Washington Narrows is a shallow 6.4 km [4 mi] channel connecting Sinclair Inlet to Dyes Inlet. The narrows has a depth of under 9 m [30 ft] (MLLW) and averages about 0.4 km [0.25 mi] wide.

In the course of facilities planning within Kitsap County, two models were used to study water quality and mixing: a mathematical ecological model applied by EPA to a part of Puget Sound and the University of Washington's physical model of Puget Sound. Descriptions of the models and a discussion of their capabilities and limitations are presented in Appendix C. Generalizations about currents and dispersions characteristics of marine waters in the planning area based on the models are difficult to make. Conditions vary not only by location, but are also relative to tidal cycle and the period of year. The University of Washington model (Reference 20) describes three receiving water sites pertinent to the Sinclair Inlet facilities plan: Enetai, located off the east side of Manette Point; the Puget Sound waters off Manchester; and Sinclair Inlet. The following descriptions are from model operations under ideal conditions, however, actual field conditions, particularly wind speed and direction, will alter to some degree the current and dispersion characteristics observed in the model.

At the Enetai site, no field data were gathered by the facilities planner to confirm the tidal cycles run on the University of Washington model. However, based on the model's reliability nearby, the predicted results can be assumed to be reasonably accurate. At this site, flood tides produce strong currents and turbulence, but ebb-tides create a calm area near shore with much less mixing.

The Manchester site is adjacent to the main body of Puget Sound. Field data generally verify the results of the physical model, although somewhat stronger currents, up to 0.5 knots as opposed to 0.3 knots, were measured in the field. Direction of flow is predominately north and northeast at virtually all phases and ranges of tides. Only at the ebb of a spring tide was any southerly flow noted at the point of observation. It is difficult to quantify the absolute magnitude because of tidal cycle variations and strengths, but a general conclusion about the flow at the Manchester site is that it shows a net movement into Puget Sound. Small amounts of flow from the Manchester site can be carried into Rich Passage on floodtides, but these flows are not visible at the west end of the passage and are flushed out again on the ebb.

The currents at the Sinclair Inlet site were verified by field data to test monitoring accuracy. Currents at this site are weak (0.2 to 0.3 knot) with a slow, oscillating flow, giving a net transport to the east.

## Marine Water Quality

### Port Orchard System General Conditions

The Port Orchard system, particularly with reference to the waters in Sinclair Inlet and Dyes Inlet, exhibits seasonally high coliform and nutrient levels, low dissolved oxygen levels and a typical lack of stratification.

High coliform bacteria levels are found in the waters immediately following periods of heavy rainfall. The coliform level is an important public health indicator of bacterial and viral contamination of waters. High coliform levels in surface waters indicate sources of inadequately treated domestic sewage in contact with the waters. In the study area, coliforms may be contributed by either combined sewer overflows and bypasses or septic drainfield seepage. Coliform levels from quarterly monitoring surveys are shown in Table 5. Levels beyond DOE standards appear frequently.

Levels of nutrients are generally high year-around with an occasional depletion of nitrates in early summer. The waters of the Port Orchard Bay system are nutrient rich, a characteristic shared with Puget Sound. Abundant quantities of nitrogen, phosphorous and other nutrients are available at all depths throughout the system, with one notable exception. In the early summer the increase in daylight hours triggers algae blooms, which are limited mainly by the amount of nitrate-nitrogen in the upper 5 m [15 ft] (the photic zone) of the water. During this period, rapid algae growth depletes the level of nitrate from the upper zones and, therefore, Port Orchard waters are referred to as "nitrate-limited".

High dissolved oxygen levels are found in the spring and summer months within the Port Orchard system. Algal photosynthetic activi-

## Table 5. QUARTERLY MONITORING OF COLIFORM BACTERIA LEVELS[a]

(Number /100 ml)

| Sinclair Inlet Sampling Stations | 6/12/72 | 8/29/72 | 12/27/72 | 3/7/73 | 6/19/73 | 9/5/73 | 12/17/73 | 3/5/74 | 6/24/74 | 9/17/74 | 1/7/75 | 3/18/75 | 6/10/75 | 9/12/75 | 12/19/75 | 3/12/76 | 6/9/76 | 3/1/77 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Off Annapolis/Retsil STP[b] | 40 | 43 | 460 | 93 | >1100 | <4 | >1100 | 240 | - | 43 | 150 | 23 | 15 | 4 | >1100 | 23 | 23 | 240 |
| 2. Off Port Orchard STP | 150 | 11 | >1100 | 4 | 460 | 9 | >1100 | 460 | 15 | 4 | 460 | 75 | <4 | 9 | 240 | 23 | 43 | 460 |
| 3. Off Port Orchard Yacht Club | 40 | <4 | 460 | 93 | 9 | 9 | >1100 | 240 | 4 | 240 | 290 | 23 | 15 | 23 | 75 | <3 | 15 | 240 |
| 4. Gorst (off Rock Quarry) | 230 | 23 | 1100 | 1100 | >1100 | <4 | >1100 | 1100 | 93 | 240 | 460 | >1100 | 460 | <4 | 150 | 23 | 93 | 240 |
| 5. Off Charleston STP | 90 | <4 | 210 | 93 | <4 | 9 | >1100 | 43 | 4 | 75 | >1100 | 240 | 23 | 9 | 150 | 1100 | 43 | 43 |
| 6. Off N.Y. Crane at Naval Shipyard | 40 | 23 | >1100 | 93 | 15 | 1100 | >1100 | 93 | 4 | 7 | 240 | 43 | 23 | 1100 | 43 | 240 | 23 | 460 |
| 7. Off Manette STP (Port Washington Narrows) | - | - | 1100 | 1100 | 4 | 14 | >1100 | >1100 | - | - | - | >1100 | - | - | - | - | - | 43 |

[a] Washington State DOE Classification of Sinclair Inlet: "A - special conditons" - total coliforms not to exceed median values of 1000/100 ml. When associated with any fecal source, less than 20 percent should exceed 2400/100 ml.

[b] Sewage Treatment Plant (STP).

Source: Kitsap County Department of Public Health.

ties during bloom periods produce high dissolved oxygen concentrations, often up to the saturation level. On the other hand, algal decomposition after the bloom period consumes large amounts of dissolved oxygen. Oxygen depletion causes odors and can adversely affect marine organisms.

There is a general lack of stratification throughout the Port Orchard Bay system. Stratification is the layering of water of different densities. This can be water of different temperatures or compositions, e.g., salt versus fresh water. Stratification reduces the volume available for mixing of a discharged effluent.

## General Water Quality Conditions Within the Study Area

Information on the quality of waters in the planning area has been recorded since 1932. Marine water quality conditions in the study area may be described as excellent but with local bacteriological problems in areas that are subject to poor flushing. The applicable marine water quality regulations and standards are given in Appendix A. The DOE classifications and general water quality conditions within the study area are summarized below:

Sinclair Inlet. Classified "A-special conditions" allowing higher coliforms; considered acceptable, but frequent violations of the coliform standards.

Dyes Inlet/Port Washington Narrows. Classified "A-special conditions"; acceptable water quality with frequent violations of coliform standards and occasional violations of dissolved oxygen standards.

Rich Passage. Classified "AA"; acceptable water quality, with only occasional violations of standards, probably due to natural causes.

Port Orchard. Classified "AA"; considered acceptable with frequent violations of bacteriological and turbidity standards in the Burke Bay/Brownsville area north of Sinclair Inlet planning area.

## BIOLOGICAL MARINE ENVIRONMENT

The marine environment within the waterways, inlets and passages of the Port Orchard system is a complex ecosystem that is susceptible to changes induced by human activities. The Port Orchard system forms part of the larger Puget Sound system along the Washington coast. The Kitsap County marine environment has been described in detail in *Basic Data and Related Sources to Shorelines* (Reference 24).

## Marine Habitats

The marine shoreline and nearshore waters can be divided roughly into three types of habitat based upon bottom type and distance from the shore. These are: (1) River-Creek Mouth; (2) Open-Mud Bays and (3) Sand-Gravel-Cobble Beach. A brief description of each habitat along with locations and characteristic associations is given in Table 6. A more detailed discussion of these units is found in Appendix D-1. Species lists of aquatic organisms probably occurring within the study area are given in Appendix D-2. The most common shoreline type within the study area is the Sand-Gravel-Cobble Beach which is typically inundated during high tide and covered with rockweed and sea lettuce. Eel grass in the subtidal areas plays an important role in the nearshore ecology.

Plant and animal life within the marine environment normally exhibit a vertical stratification representing three ecological niches. They are the benthic, water column and surface zones, which are distinct and yet interact with each other. The benthic zone includes the bottom sediments and the associated immediately overlying areas. The water column zone is that portion of the marine environment where the water column meets the benthic zone up to 0.7 m [2 ft] under the water surface. The surface zone is that portion of the water environment above the water column zone to 2 m [6 ft] above the surface of the water body. A brief description of each zone along the locations and characteristic associations is given in Table 7. A more detailed discussion of these units is found in Appendix C.

## Algal Production

Algal concentration studies for Sinclair and Dyes Inlet were performed in *Ecologic Modeling of Puget Sound and Adjacent Waters* (Reference 22). Algal concentrations were studied for their value as an indicator of productivity in the marine environment and as an indicator of other factors, such as nutrients, light, certain growth coefficients and zooplankton. Computed algal biomass concentrations in Dyes and Sinclair Inlets are shown in Figure 11. A species nonspecific algal biomass was computed, based on 80 mg biomass corresponding to one mg chlorophyll a.

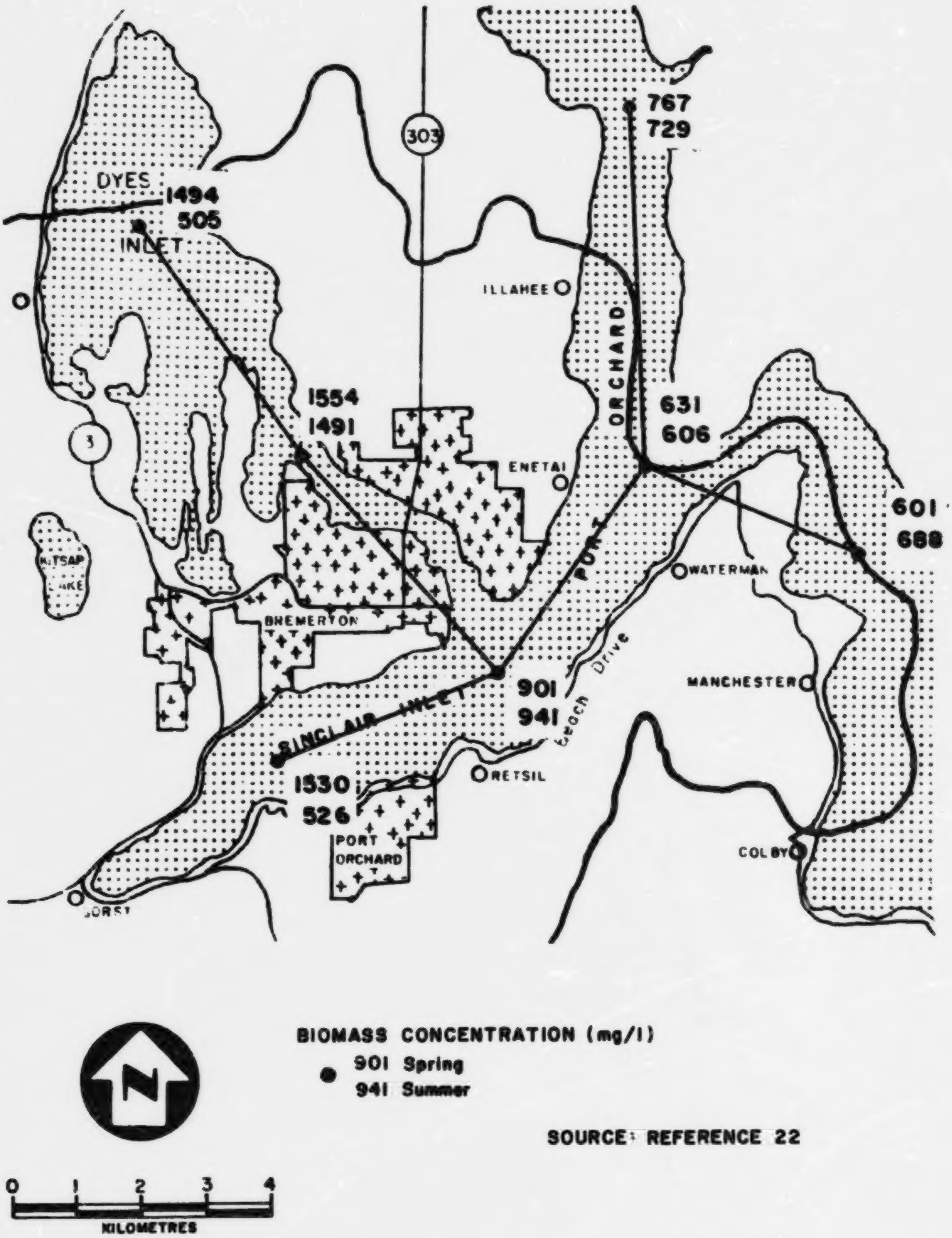
In winter, the model computed the lowest algal biomass with an average of 800 µg/l in Port Orchard. Spring values were higher, presumably due to increased light (heat) energy and upstream nutrient inputs. Concentrations exceeding 1,500 µg/l were computed for Sinclair Inlet, Port Washington Narrows, Dyes Inlet and Liberty

Table 6. MARINE HABITAT TYPES WITHIN THE STUDY AREA

| Habitat | Description | Locations and Examples | Characteristic Associations |
|---|---|---|---|
| River-Creek Mouth | Estuarine zone where creek mouth meets marine waters. This zone extends to several meters below the low tide level and is subject to tidal and seasonal salinity changes. | Open systems-with direct creek outlet to marine waters-such as Chico Creek at Dyes Inlet. | Anadromous fish nursery areas-At depths greater than 1 ft below mean lower low water are productive eelgrass beds. Associated fish may include starry flounder, stickleback, eulachon, surf perch, sculpin and sole. |
| | | Closed systems-creek mouth enclosed seasonally or permanently by sand spits or man-made obstructions, such as Annapolis Creek and other small creeks tributary to Sinclair Inlet. | Important waterfowl and shorebird habitat-sandy, silty bottom supports march grasses and invertebrates. During extreme climatic conditions, serves as important waterfowl shelter and feeding area. |
| Open-Mud Bays | Bays with limited circulation due to restricted inlet/outlet. The marine environment has no substantial fresh-water source and typically has an extensive intertidal zone, large mud flat areas and marsh grasses around the periphery. | Dyes Inlet system-including Oyster Bay, Ostrich Bay and Phinney Bay. Also includes lower end of Sinclair Inlet. | Subtidal eelgrass beds provide important feeding and spawning areas for Pacific herring, starry flounder, stickleback, eulachon, surf perch, sculpin and various flounder and sole species. Dungeness crabs, oysters and oyster drills are found in Chico Bay. Smelt spawning areas are along western Dyes Inlet shoreline. |
| Sand-Gravel-Cobble Beach | Typical shoreline type within Kitsap County. Shoreline is predominantly gravel and cobble gradating to semi-sandy substrate in the intertidal areas. | Major shoreline areas along Sinclair Inlet and Port Orchard. | March grass limited or absent, rockweed and sea lettuce typical in intertidal areas some eelgrass in subtidal areas. Typical invertebrate fauna consists of butter, littleneck and bent-nose clams, barnacles, shore and butter clams, tube worms, mussels and periwinkles. |

Table 7. VERTICAL ZONES WITHIN THE MARINE ENVIRONMENT

| Zone | Description | Locations and Examples | Characteristic Associations |
|---|---|---|---|
| Benthic Zone | Bottom-dwelling plant and animal community, includes infauna which may burrow several feet into substrate, epifauna which inhabit surface of substrate and demersal fish species. | Shallow portions of Dyes Inlet where bottom depth is less than 6 m [20 ft] deep. | Washington and manila clams, cockles, lean dog whelk and over 15 species of polychaetes dominated by lumberinerids, ampharetids, orbiniids and trichobranchids. For fish species, see Sinclair Inlet below. |
| | | Southeastern end of Sinclair Inlet where bottom depth is less than 9 m [30 ft] deep. | Washington and other small clams: *Axinopsis serricatus* and *Psephidia lordi* are found in Sinclair Inlet, also lumberinerid and cirratulid polychaetes and cumaceans. Benthis fishes include: sping dogfish; bay goby; great, roughback and Pacific sculpins; speckled sanddab; starry flounder; and flathead, rock, slender, English, c-o and sand sole. |
| Water Column Zone | Mid-depth waters that may show gradations in temperature with moderate-to-good circulation. Some areas may be filled with kelp fronds forming a forest-lide environment. | Sinclair Inlet, Dyes Inlet, Port Orchard, Rich Passage and Puget Sound. | Important local fish species in the water column include stickleback, eulachon, bay pipefish, pricklebacks, shiner and pile perch, striped and white seaperch, sturgeon and pygmy poacher. Fishes favoring algal and other vegetative associations include northern clingfish, plainfin midshipman, blackbelly eelpout, whitespotted greenling and longspine combfish. Other pelagic fishes include Pacific herring, salmon, Pacific cod, Pacific hake, walleye pollock and Pacific tomcod. |
| Surface Zone | Surface waters which are strongly influenced by light, wind, temperature and human activities such as boating. | All marine waters within study area. | Important zone for phyroplankton and zooplankton production. Plankton population forms first step of food chain for benthic invertebrates and fishes. Fishes in surface zone are similar to water column zone with a preference for those tolerating warmer waters. |


DYES INLET
1494
505
767
729
303
ILLAHEE
1554
1491
3
ORCHARD
631
606
ENETAI
601
688
KITSAP LAKE
PORT
WATERMAN
BREMERTON
Beach Drive
MANCHESTER
901
941
SINCLAIR INLET
RETSIL
1530
526
PORT ORCHARD
COLBY
GORST
N
BIOMASS CONCENTRATION (mg/l)
● 901 Spring
941 Summer
0
1
2
3
4
KILOMETRES

SOURCE: REFERENCE 22

FIGURE 11 COMPUTED ALGAL BIOMASS CONCENTRATIONS

Bay. Model results show that summer algal concentrations dropped to approximately 500 μg/l in the bays and inlets while remaining relatively high in Port Washington Narrows and near Bremerton. By contrast, the main channel of Puget Sound, near Bainbridge Island, ranges from 5 μg/l in the winter to 348 μg/l in the spring. Model results can only approximate true conditions, which could vary from those predicted.

The seasonal pattern of variation in algal concentration tends to imply that phytoplankton in Puget Sound are primarily limited by light and secondarily by the input of nutrients. Continuously high concentrations from spring to summer in Port Washington Narrows reflects the nutrient loading from the Manette Sewage Treatment Plant wastewater outfall on the western shore of East Bremerton and the return of much of that wastewater at each tidal cycle.

## Fisheries and Aquaculture

There are two major salmonid-producing stream systems in the study area which support limited runs of coho salmon, chub salmon and steelhead trout. They are the Chico Creek system with its Dickenson, Lost and Kitsap Creek tributaries and the Blackjack Creek system which enters Sinclair Inlet. Smaller creeks with less than 3 km [2 mi] of potential salmon-spawning areas are: Illahee Creek off of Port Orchard; Mosher Creek off of Dyes Inlet; and Anderson, Ross, Annapolis and Sullivan Creeks which drain into Sinclair Inlet. Adult salmon runs normally occur in the fall, while steelhead migrate upstream in the fall and spring. The shoreline areas of central Kitsap County are also important for overall salmon production for much of Puget Sound. Juvenile salmon descending from inland waters to the ocean in the spring and summer typically remain close to the shoreline for food and protection from predators. Salmon are also commercially reared in floating pens by a private firm at Clam Bay near Manchester and off Fort Ward on Bainbridge Island.

Puget Sound also produces major groundfish resources, including several flatfish, rockfish, herring, smelt and other species. Some of the species present are dependent on shallow shoreline reaches for spawning and/or nursery areas. The commercial and sport harvest of shellfish in the area is relatively intense, with emphasis on oysters, hardshell clams, crabs and shrimp. Limited commercial production of Pacific oysters occurs in lower Dyes Inlet. Aquacultural resources are shown generally on Figure 12.

Commercial fishing statistical areas for Kitsap County are segregated by port. Within the planning area, marine landings are grouped into: (1) the Bremerton port which includes Sinclair Inlet, Dyes Inlet and lower Port Orchard up to Point White and (2),

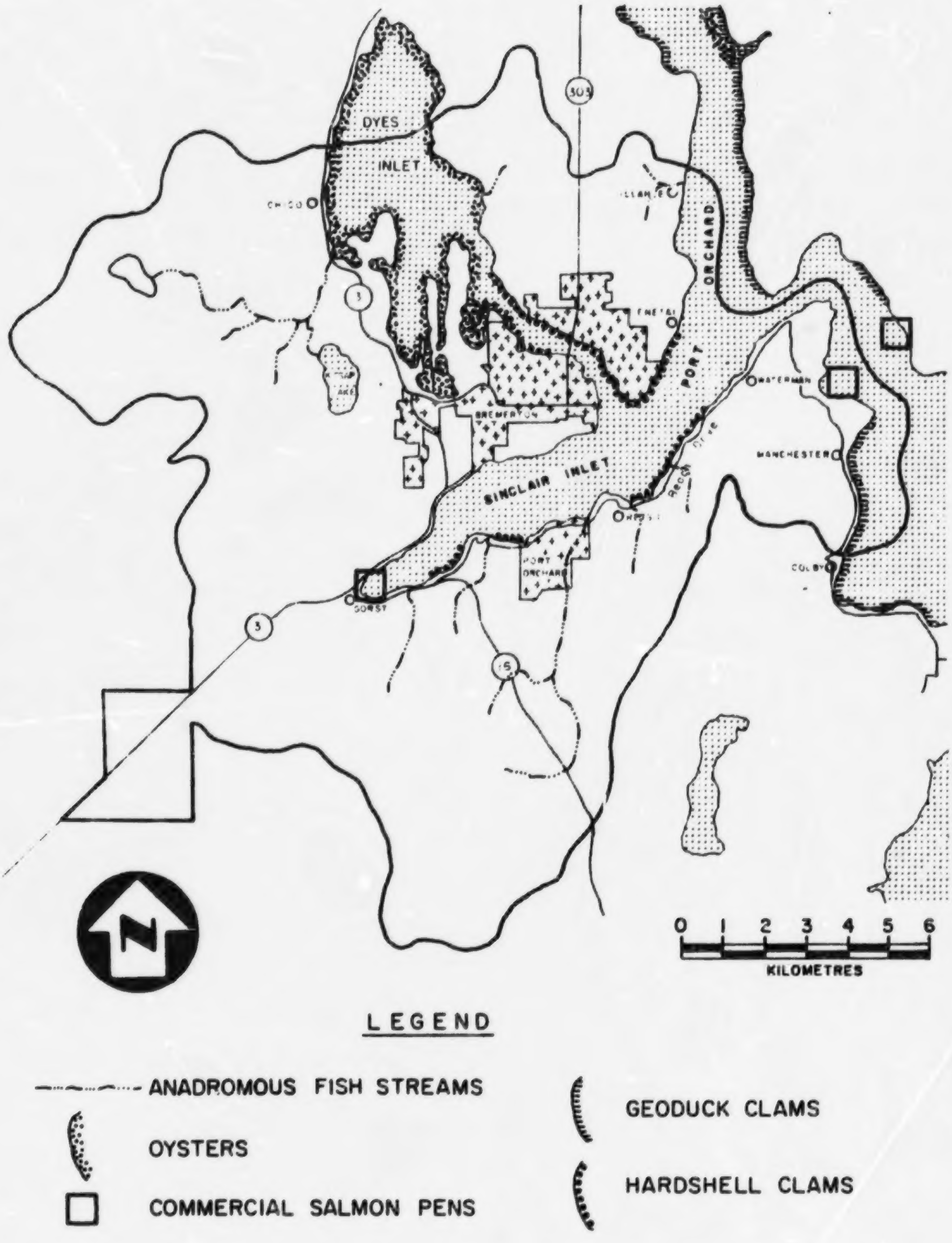

DYES
INLET
303
CHICO
ILLAHEE
ORCHARD
ENETAI
PORT
3
BREMERTON
WATERMAN
MANCHESTER
SINCLAIR INLET
PORT ORCHARD
COLBY
GORST
3
16
N
0 1 2 3 4 5 6
KILOMETRES
LEGEND
ANADROMOUS FISH STREAMS
OYSTERS
COMMERCIAL SALMON PENS
GEODUCK CLAMS
HARDSHELL CLAMS

FIGURE 12 AQUACULTURAL RESOURCES

Fletcher Bay port which essentially covers the central portion of Port Orchard Bay. The three-year average commercial weight and dollar value of marine landings within these statistical areas are given in Table 8. The statistics reflect commercially valuable and harvestable species but do not necessarily reflect all resident species, annual or seasonal abundance of species or Fisheries Department Harvest restrictions. Salmon were not included in individual port catch statistics because they were categorized as a wide-ranging species not specific to particular areas.

## ARCHAEOLOGICAL, HISTORICAL AND OTHER CULTURAL RESOURCES

### Archaeological Resources

Existing archaeological site data within the study area are limited and cover only a few localized areas. Documentation of archaeological sites is largely a product of opportune surveying along roadcuts, excavations and selected areas such as promontories, rock-shelter areas and water bodies. Areas identified with a potential for containing archaeological remains include all of the shoreline along Sinclair Inlet, Dyes Inlet, Port Orchard Bay and Puget Sound. Other sensitive areas are along the banks of lakes, large ponds and major streams such as Blackjack and Gorst Creeks. A detailed discussed is presented in Appendix E. Four archaeological sites have been recorded within the study area by the State Historic Preservation Officer (Washington State Department of Parks and Recreation). No recorded sites lie within the alternative sites for treatment facilities and pumping stations or within a 100 m [300 ft] wide corridor along the alternative pipeline routes.

A literature search and field survey conducted in April 1977 did not reveal any further sites or artifacts of archaeological significance. The treatment plant sites and proposed pipeline corridors along roads have been severely disturbed in the past and many areas have been covered by layers of dirt fill. However, the possibility of buried sites or artifacts in the project area exists, particularly along the shores of Dyes and Sinclair Inlets.

### Historical Resources

The historic resources of the study area are centered around the older portions of Bremerton and Port Orchard which contain structures from the late 1800's to the early 1900's. Central Kitsap County has two historical sites listed in the National Register of Historic Places. They include: The U.S.S. Missouri moored in the west end of the Puget Sound Naval Shipyard and the Navy View Apartments (Sid-

## Table 8. AVERAGE MARINE LANDS AND VALUE WITHIN THE PLANNING AREA, 1972-1974

| Species | Fletcher Bay | | Bremerton | |
|---|---|---|---|---|
| | (kg)[a] | ($) | (kg) | ($) |
| Pelagic fish | | | | |
| Herring | 9,887 | 4,350 | 15,414 | 6,782 |
| Silver smelt | 33 | 14 | 106 | 46 |
| Ling cod | 11 | 6 | - | - |
| True cod | 2 | - | - | - |
| Rockfish | - | - | 32 | 7 |
| Blue perch | 203 | 36 | 3,287 | 570 |
| Silver perch | - | - | 142 | 48 |
| White perch | 957 | 415 | 10,118 | 4,383 |
| Pelagic total | 11,098 | 4,828 | 29,099 | 11,829 |
| Benthic species | | | | |
| Butter clam | 60,449 | 12,218 | 236 | 47 |
| Horse clam | 9,631 | 1,065 | - | - |
| Littleneck clam | 33,798 | 17,845 | 9,490 | 5,011 |
| Pacific hard clam | 259 | 84 | 455 | 148 |
| Sea cucumber | 976 | 537 | 976 | 537 |
| Geoduck | 193,497 | 41,871 | - | - |
| Benthic total | 298,510 | 73,530 | 11,157 | 5,757 |
| TOTAL | 309,708 | 78,358 | 40,256 | 17,586 |

[a] 1 kg = 2.2 lbs.

Source: Reference 21

ney Hotel) at Prospect and Frederick Streets, Port Orchard. Both landmarks have been brought from other areas to their present locations.

Numerous structures have been recognized by the Kitsap County Historical Society in Bremerton and surrounding towns. Most buildings listed by the Society were built from 1885 to 1916 and are four- to eight-room residences. A large number of these residences are concentrated in the easterly portion of Bremerton south of the Port Washington Narrows. A potential pipeline corridor between Manette- and Charleston may pass by structures currently listed by the Society or pass through areas with residences of equal or greater historic interest which have not been nominated for the Society's list.

## DEMOGRAPHY

The study area is the urbanized portion of a semirural county. Only two incorporated cities are located within the study area: Bremerton with 37,000 persons and Port Orchard - the Kitsap County seat-- with 4,000 persons. Small unincorporated communities, include Annapolis/Retsil, Orchard Heights, Manchester, Gorst, Navy Yard City and other small clusters of urban development.

The population of the area has grown substantially in the last few decades and is continuing to grow. This growth has been largely related to the operation of local military installations. The location of the Puget Sound Naval Shipyard at Bremerton in the late 1800's, two World Wars and two limited conflicts, with their accompanying increases in shipyard and other military installation activity, and the recent selection of Kitsap County for the site of the Navy Trident Nuclear Submarine Base have all produced population surges as shown in Table 9.

Sub-area growth figures presented in Table 10 reflect the increased densities in the central portion of the county from 1960 to 1975, particularly around Bremerton. Population figures for Bremerton may vary by as much as 5,000, depending on the number of ships, and aircraft carriers, at the Puget Sound Naval Shipyard at any time (Reference 23).

The data in Table 10 also indicate increasing growth in the area south of Sinclair Inlet (South Kitsap) in recent years. This represents, in part, a southward migration of Kitsap County residents toward Port Orchard and the Southworth-Colby communities along Puget Sound. In part, it also results from an influx of former Seattle and Tacoma residents. In some respects, Port Orchard is becoming a

Table 9. POPULATION GROWTH, KITSAP COUNTY AND CITIES IN STUDY AREA: 1910-1975

| | Kitsap County Total | Bremerton | Port Orchard |
|---|---|---|---|
| 1910 | 14,000 | 3,000 | 700 |
| 1920 | 30,000 | 8,900 | 1,400 |
| 1930 | 29,000 | 10,000 | 1,100 |
| 1940 | 46,000 | 15,000 | 1,600 |
| 1950 | 77,000 | 27,700 | 2,300 |
| 1960 | 84,000 | 27,000 | 2,800 |
| 1970 | 102,000 | 35,300 | 3,900 |
| 1975 | 116,000 | 37,100 | 4,000 |

Sources: Reference 23

Table 10. SUB-AREA GROWTH, 1960-1975

| Area | Census Division | 1960 | 1970 | 1975 |
|---|---|---|---|---|
| North | **1-3** | 9,600 | 12,100 | 14,000 |
| Central | 4-8 | 24,800 | 24,100 | 28,800 |
| South | 12, 14-16, and 18 | 16,300 | 21,700 | 26,700 |
| Bainbridge Island | 9-11 | 6,400 | 8,500 | 9,500 |
| Bremerton (incorporated area) | B | 27,000 | 35,300 | 37,100 |
| County Total: | | 84,100 | 101,700 | 116,100 |

Source: Reference 23.

"bedroom" community for Tacoma, due to its easy access by highway. Its current growth rate is estimated to approximate that of Bremerton. In addition, persons outside of Washington, including families of retired military personnel are moving to the area (References 23 and 24).

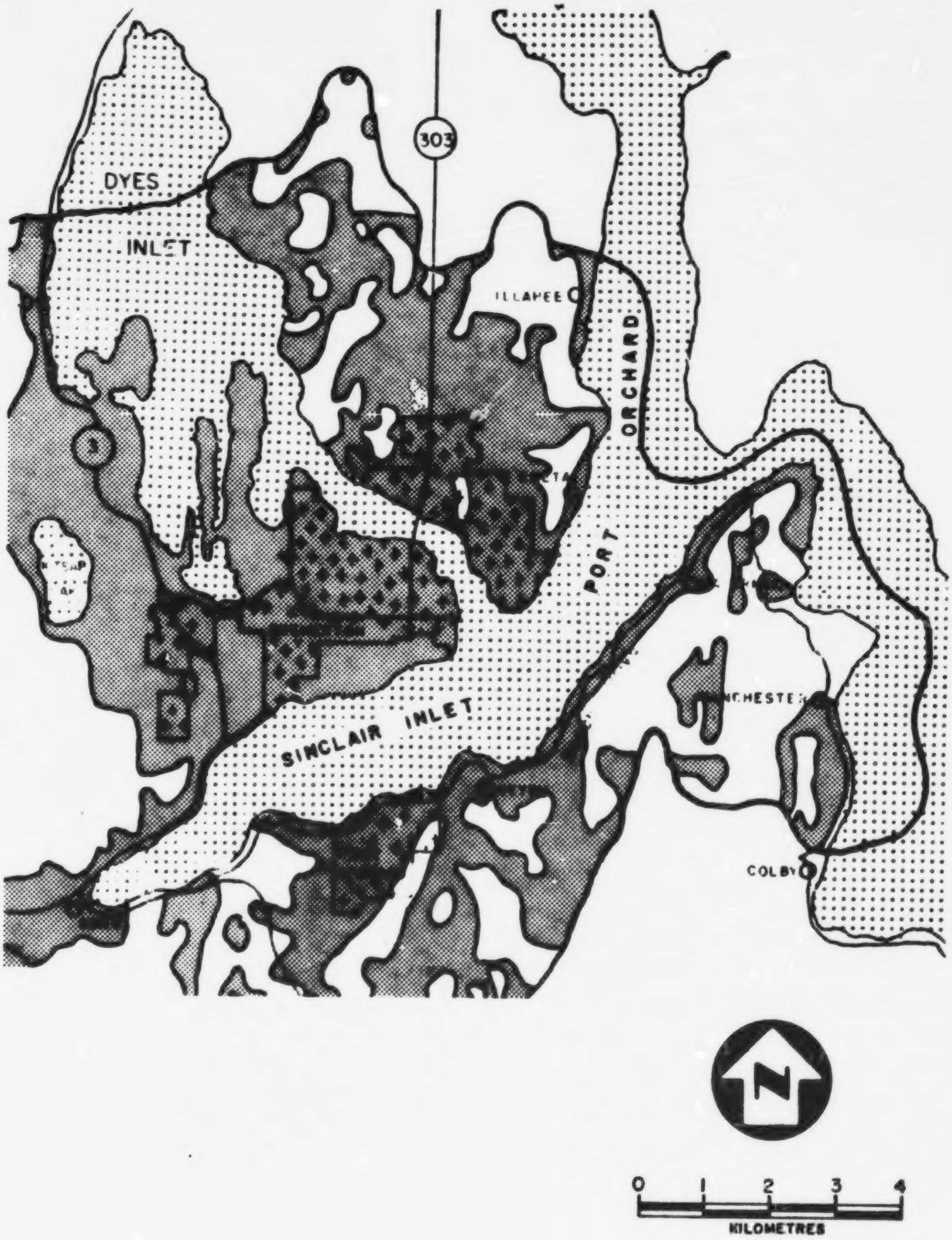
Total 1975 population for the study area, defined as sub-basins 11, 23, 24, 26 and 27 of Water Resources Inventory Area (WRIA) 15, was estimated as 69,300. Approximately 49,500 of these people were in the Bremerton drainage area, which includes the East Bremerton-Illahee-Tracyton-Fairview communities and the area between Port Washington Narrows and lower Chico Creek. The balance of nearly 20,000 was concentrated in the Port Orchard-Annapolis area. The Gorst and Manchester areas accounted for approximately 4,500 of these 20,000 persons. These figures represent revised estimates provided by Arthur D. Little, Inc., in conjunction with the Kitsap County Planning Department. The population concentration generally correspond with the developed portions of the study area, as shown in Figure 13.

According to the 1970 census, 96.1 percent of the population was white, with blacks accounting for 1.6 percent and other groups, 2.9 percent. The population characteristics of the county population tended to differ from the state in general. As an example, 10.0 percent of the population was 65 or older in 1970, compared to a statewide average of 8.2 percent. Because of this fact, a higher than average number (15 percent) of county population receives Social Security payments. Due to the presence of the military (the economy of the county is heavily dependent on employment related to the U.S. Navy), the percentage of males (51.2 percent) was higher than the state average of 49.5 percent. Approximately 15 percent of the 1970 population was military personnel and dependents, and this proportion increased significantly whenever large ships were in port. Approximately 25 percent of 1970 county population was of school age.

## FUTURE POPULATION DISTRIBUTION

Four recent estimates for Kitsap County in the year 1985 ranged from 141,000 to over 166,000. All of these projections assumed that Trident-related growth would be the most important single factor in expansion, accounting for an increase of 27,000 to 32,000 persons (Reference 23). As a result, a significant upsurge in population in Central Kitsap north of Bremerton can be expected, with continuing spillover southward.

The most recent projections of population growth in the study area for the design period have been supplied by Arthur D. Little, Inc., with revisions by Bremerton and Kitsap County planners. These are presented in Table 11. The figures in Table 11 represent a downward revision of total population for the study area and for Bremer-


DYES
INLET
303
ILLAHEE
3
ORCHARD
PORT
SINCLAIR INLET
MANCHESTER
COLBY
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0
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4
KILOMETRES

FIGURE 13 DEVELOPED AREA

Table 11. TOTAL AND SEWERED POPULATION PROJECTIONS

| Drainage Area | WRIA Sub-basin | 1975 Total[b] | 1975 Sewered[c] | 2000 Total[d] | 2000 Sewered[d] |
|---|---|---|---|---|---|
| Bremerton[a] | 11,23 | 49,842 | 37,000 | 59,800 | 56,600 |
| Wildcat Lake | 23 | 912 | | 750 | 0 |
| Subtotal | | 50,754 | 37,000 | 60,550 | 56,600 |
| Gorst | 24 | 1,545 | 0 | 2,250 | 1,000 |
| East Gorst | | 400 | 0 | 400 | 400 |
| Subtotal | | 1,945 | 0 | 2,650 | 1,400 |
| Port Orchard | 26 | 9,677 | 4,900 | 8,200 | 7,450 |
| Retsil | | 4,399 | 3,141 | 12,800 | 9,300 |
| Subtotal | | 14,076 | 8,041 | 21,000 | 16,750 |
| Waterman | 27 | 500 | 0 | 550 | 0 |
| Manchester | | 2,025 | 503 | 4,250 | 3,300 |
| Subtotal | | 2,525 | 503 | 4,800 | 3,300 |
| TOTAL | | 69,300 | 45,544 | 89,000 | 78,050 |

[a] Includes Fairview, Tracyton, Illahee, Kitsap Lake and Dyes Inlet

[b] Source: Revised Population Projections, March 1977 by CH2M Hill (Unpublished)

[c] Source: Reference 1.

[d] Source: Reference 2.

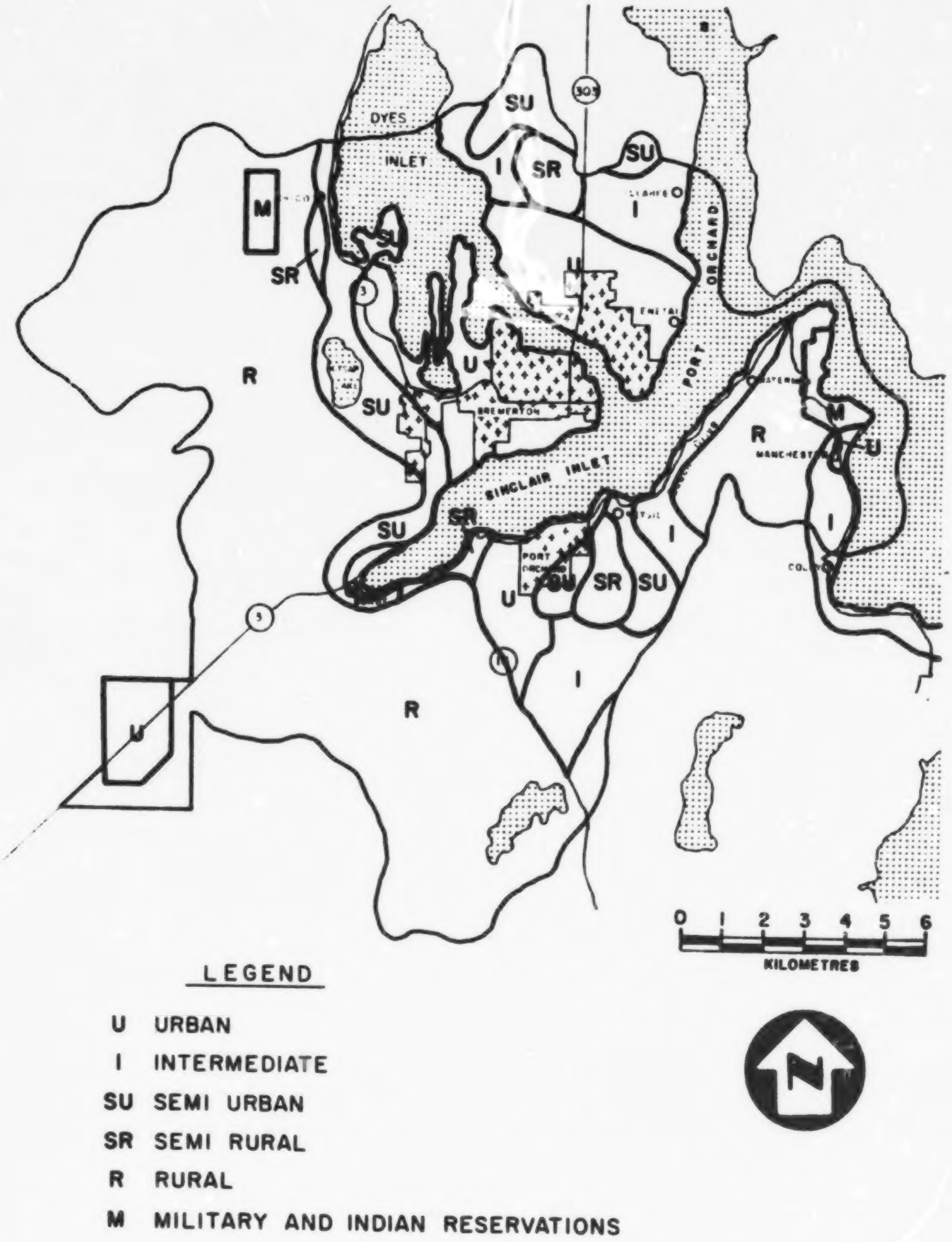
ton in the design year, 2000. Earlier estimates had placed the total for that year at 97,000, with the Bremerton drainage area accounting for 72,000 of the total. Population in the Study Area is now projected to increase from an estimated 69,300 in 1975 to approximately 89,000 in the year 2000 (Reference 2). All subregions within the Study Area have also been projected to increase 19 percent to 60,550 in 2000; the Port Orchard/Retsil area by 49 percent to 21,000; the Waterman/Manchester area by 90 percent to 4,800 and Gorst area by 36 percent to 2,650 persons.

## FUTURE LAND USE

Wastewater treatment plants are constructed to meet projected use demand and water quality standards. The study area will continue to show increasing population densities, centering around Sinclair Inlet. Future land use plans, as expressed in the *Kitsap County Comprehensive Plan* put forth a goal to concentrate urban development in and around existing urban areas, while preserving to the maximum possible extent the rural and semi-rural life style of the county. (Reference 26). The Plan designates "Urban," Intermediate" (or Transitional), and "Rural" areas, with "Intermediate" being either "Semi-urban" or "Semi-rural," depending upon the extent of utilities and services demanded by growth pressures. The proposed Urban, Intermediate (Semi-urban or Semi-rural) and Rural areas within the study area are shown in the Kitsap County Comprehensive Plan projected land use profile map shown in Figure 14.

Urban areas are those areas which have utilities, transportation facilities and other urban services which would permit highest intensity uses consistent with applicable planning policies, ordinances, performance criteria and state and federal regulations. According to the Plan, the study area is expected to be increasingly urban around the shores of Sinclair Inlet. Most of the Bremerton drainage area is classified as Urban or Transitional. The Manchester, Gorst and Port Orchard-Retsil/Annapolis areas are also classed as Urban, with the latter being surrounded by a large Transitional area.

Different intensity uses may be recommended with each of these land use classifications. In Transitional areas, development will be treated on a case-by-case basis, depending on need for and proximity to services, character of the surrounding area, and on existing and potential land use. A Semi-rural area has a development intensity designed primarily for a low density residential use (maximum density of 5 dwelling units (d.u.)/ ha [2 d.u./ac]), an intensity that would require the provision of full public services. Semi-urban areas are Transitional areas which could be expected to develop into urban areas over time. The airport and industrial park are con-


DYES
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BREMERTON
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ORCHARD
SINCLAIR INLET
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SR
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MANCHESTER
M
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R
I
U
R
303
3
3
0 1 2 3 4 5 6
KILOMETRES
LEGEND
U URBAN
I INTERMEDIATE
SU SEMI URBAN
SR SEMI RURAL
R RURAL
M MILITARY AND INDIAN RESERVATIONS
N

FIGURE 14 PROJECTED LAND USE PROFILE MAP

sidered Transitional, as are areas to the south of Manchester, around the Colby and Southworth communities, and the southern perimeter of Bainbridge Island.

The balance of the study area is classed as Rural for planning purposes (Reference 26). Rural areas are those areas beyond the Intermediate areas where urban or semi-urban development should not occur. The County will discourage development of more than one dwelling unit per 4 ha [10 ac] in areas used, or having the potential to be used, for agriculture or forestry, with limited development in other areas and limited provision of public utilities. Rural residential development densities, where unrestricted by agriculture or forestry, are a maximum of 2.5 d.u./ha [1 d.u./ac]. Only very low intensity commercial activities would be permitted in rural areas.

At present, it is not envisioned that Rural areas or the Semi-rural portions of Transitional areas will receive sewer service (Reference 24).

## EMPLOYMENT

Employment for residents of the Sinclair Inlet study area is spread throughout the whole Kitsap County area. In addition, there is some cross-commuting between Kitsap County and Seattle to the west and Tacoma to the south. A specific breakdown of employment for the Sinclair Inlet study area is not available. However, because the work force is highly mobile in its commuting patterns, such statistics would not be particularly meaningful.

The City of Bremerton is the major urban area in the study area. Governmental employment, the Puget Sound Naval Shipyard in particular, dominates the economy in the area. The remaining federal employment is mainly associated with the Naval Supply Center and the Keyport Naval Torpedo Station, and at agencies supporting defense activities. Presently, construction at the Trident Submarine Base is also providing employment for many people in the area.

In January 1977, the Kitsap County labor force was estimated at 43,790, with an overall unemployment rate of 8.2 percent compared with 9.5 percent in January of 1976. Table 12 presents a further breakdown and comparison with State of Washington statistics. Table 13 shows a comparison of the Kitsap County resident civilian labor force and unemployment for 1973, 1975 and estimated 1977. Contract construction unemployment remained fairly consistent from 1973 through 1975 at about 3.1 percent. It is projected to increase to 6.2 percent in 1977. The employment characteristics indicate an unusually high proportion of federal government employment in the region, reflecting

Kitsap County's reliance on Defense Department employment to sustain the local economy.

A general economic decline in the period 1970 through 1974 was experienced in the Bremerton area (Reference 27). Kitsap County did not recover as fast as other northwest areas because job opportunities were limited by lack of industrial diversification. During 1974 and 1975, government employment rose as both federal and local government made significant additions. Most of the gain in the federal sector during 1973-1975 period was caused by a work force increase of 1,400 people at Puget Sound Naval Shipyard. The increase in local government employment followed substantial hiring in the local school districts (Reference 27).

Construction was relatively unaffected by the recession of the early seventies. Construction employment rose during 1974 and 1975. It is projected that employment in this industry will continue to grow in the 1977, as a direct result of the Trident Project. In addition, the Navy is planning to spend $30 million building a medical center and $10 million on other construction projects at the Puget Sound Naval Shipyard and the Keyport Naval Torpedo Base (Reference 27).

Table 12. RESIDENT LABOR FORCE AND EMPLOYMENT: KITSAP COUNTY LABOR MARKET AREA AND STATE OF WASHINGTON

| | Kitsap County | State of Washington |
|---|---|---|
| Labor force | | |
| January 1976 | 42,580 | 1,523,300 |
| January 1977 | 43,790 | 1,555,700 |
| Employment | | |
| January 1976 | 38,540 | 1,362,000 |
| January 1977 | 40,220 | 1,417,000 |
| Unemployment | | |
| January 1976 | 4,040 | 160,400 |
| January 1977 | 3,570 | 138,700 |
| Unemployment Rate | | |
| January 1976 | 9.5 | 10.5 |
| January 1977 | 8.2 | 8.9 |

Source: References 27 and 28).

Table 13. RESIDENT CIVILIAN LABOR FORCE & EMPLOYMENT IN KITSAP COUNTY FISCAL YEAR AVERAGES 1973 AND 1975 AND PROJECTED 1977

| | Fiscal Year Averages | | | | | |
|---|---|---|---|---|---|---|
| | 1973 | Percent Of Total | 1975 | Percent Of Total | 1977 | Percent Of Total |
| TOTAL | 29,410 | | 33,380 | | 35,350 | |
| Manufacturing | 1,030 | 3.4 | 1,010 | 3.0 | 1,070 | 3.0 |
| Stone, Clay, & Glass Products | 70 | .2 | 80 | .2 | 90 | .3 |
| Other Durable Goods | 540 | 1.8 | 530 | 1.6 | 580 | 1.6 |
| Food & Kindred Products | 90 | .3 | 100 | .3 | 110 | .3 |
| Other Nondurable Goods | 330 | 1.1 | 300 | .9 | 290 | .8 |
| Non-manufacturing | 28,380 | 96.6 | 32,370 | 97.0 | 34,280 | 97.0 |
| Mining | 150 | .5 | 160 | .5 | 160 | .5 |
| Construction | 950 | 3.2 | 1,040 | 3.1 | 2,200 | 6.2 |
| Transp., Comm., & Utilities | 960 | 3.3 | 990 | 3.0 | 1,010 | 2.9 |
| Trade | 4,980 | 16.9 | 5,420 | 16.2 | 5,580 | 15.8 |
| Fin., Ins., & Real Estate | 810 | 2.8 | 930 | 2.8 | 970 | 2.7 |
| Services, exc. pvt. household | 3,580 | 12.2 | 3,970 | 11.9 | 4,320 | 12.2 |
| Government | 16,950 | 57.7 | 19,860 | 59.5 | 20,040 | 56.7 |
| Federal | 12,020 | 40.9 | 14,430 | 43.2 | 14,280 | 40.4 |
| State | 1,320 | 4.5 | 1,520 | 4.6 | 1,540 | 4.4 |
| Local | 3,610 | 12.3 | 3,910 | 11.7 | 4,220 | 11.9 |

Source: Reference 27.

Trade and services increased between 1973 and 1975. Although much of this employment is seasonal in nature, increases in these categories, are anticipated in the 1975-1977 period (Reference 27).

## INCOME

The most comprehensive county-level income information is available only for the year preceding the decennial census year. The following information on income levels for 1969 was derived from the publication "Manpower Profile" from the U.S. Department of Labor (Reference 29). Median annual family income in Kitsap County in 1969 was $10,541, which as 12 percent higher than the national median family income of $9,430. A large segment of the population was categorized in the middle income level, while several localized areas contained both higher and lower income levels. Median white family income was $10,617, compared with $8,273 for blacks and $7,946 for other groups. More than $15,000 per year per family was earned by 5,525 families, which as 21 percent of the county total. In 1969 most county household earned income from direct wages and salaries, with 9 percent depending on self-employment and 15 percent receiving social security payments.

A total of 8,828 persons (9.1 percent of all county residents), comprising 1,936 families (7.3 percent of all households) received less than poverty level income. The "near poor" -- persons earning less than 75 percent of poverty level income -- numbered 5,925 (6.1 percent). Mean income of families below poverty level was $1,602. Public assistance provided income for about 4 percent of county households.

## BUSINESS AND INDUSTRY

Kitsap County's employment structure is dominated by federal employment, primarily at the Puget Sound Naval Shipyard. Table 14 indicates the breakdown of employment by industry.

The private sector of the Kitsap County economy is predominately retail trade. Table 13 indicates a total of 614 retail firms with payrolls. These firms employ about 4,575 persons, with a total payroll of over $24 million (Reference 30).

In 1972, service industries employed about 1,000 persons with a total payroll of $4.9 million (Reference 31) There were 60 manufacturing establishments in 1972, employing 700 persons, with a total

Table 14. SINCLAIR INLET STUDY AREA, MAJOR EMPLOYERS

| Employer | Percentage |
|---|---|
| Federal Government | 49.6% |
| Retail & Wholesale Trade | 13.4% |
| Local Government | 5.5% |
| Construction | 3.5% |
| Manufacturing | 3.3% |
| Finance | 3.2% |
| Transportation | 3.1% |
| Other | 0.5% |

Source: Reference 26.

payroll of $5.6 million (Reference 32). Wholesaling provided employment for 375 persons with total payroll of $3.5 million. Comparable statistics for the State of Washington are included in Table 15.

## TAX BASE AND ASSESSED VALUES

Property tax collections in Kitsap County are based on the application of a levy (tax rate) to every $1,000 of assessed valuation (AV). In 1975, the AV rates changed to 100 percent of market value. All taxing jurisdictions except schools and the State of Washington have a budgetary limitation. This limitation, imposed by the State, restricts their revenue collections to not more than 106 percent of the highest amount collected in any of the previous three years (Reference 33).

The restriction does not apply, however, to increases in valuation resulting from new construction. The recent increase in residential and commercial building activity, coupled with recent assessed evaluation increases, has generated additional revenue for the cities of Bremerton and Port Orchard. Total new construction in the County rose by 93 percent in 1975. For information on construction trends, see the section on "Land and Property Values." (Reference 34).

## Table 15. NUMBER OF ESTABLISHMENTS, NUMBER OF EMPLOYEES & ANNUAL PAYROLL, KITSAP COUNTY AND STATE OF WASHINGTON, 1972

| | Kitsap County | State of Washington |
|---|---|---|
| **Manufacturing Industries** | | |
| No. of Establishments | 50 | 5,343 |
| No. of Employees | 700 | 224,700 |
| Payroll | $5,600,000 | $2,299,000,000 |
| **Retailing** | | |
| No. of Establishments[1] | 614 | 21,596 |
| No. of Employees | 4,575 | 180,481 |
| Payroll | $24,179,000 | $959,811,000 |
| **Wholesaling** | | |
| No. of Establishments | 77 | 6,532 |
| No. of Employees | 375 | 65,285 |
| Payroll | 3,531,000 | $607,037,000 |
| **Service Industries** | | |
| No. of Establishments[1] | 260 | 75,897 |
| No. of Employees | 1,013 | 12,060 |
| Payroll | 4,925,000 | $465,011,000 |

1. Excludes establishments which do not have payroll

Source: References 30, 33, 34 and 35.

Table 16. KITSAP COUNTY ASSESSED VALUATION, NEW CONSTRUCTION, AND HISTORICAL TREND

| | Total assessed valuation | New construction | Net assessed valuation | Percent increase |
|---|---|---|---|---|
| 1970 | $ 629,189,100 | $17,251,870 | $611,937,230 | 17.7% |
| 1971 | 736,239,562 | 24,851,825 | 711,387,737 | 16.3% |
| 1972 | 772,260,264 | 22,834,746 | 749,425,518 | 5.3% |
| 1973 | 894,292,468 | 35,514,411 | 858,778,057 | 14.6% |
| 1974 | 965,143,188 | 36,088,389 | 929,054,799 | 8.1% |
| 1975 | 1,033,793,823 | 69,701,345 | 964,092,478 | 3.8% |
| 1976 | 1,424,606,834 | (1) | (1) | |

(1) These figures were not available as of April, 1977.

Source: Reference 34.

Residential land and improvement represents approximately 88 percent of total assessed valuation in Kitsap County. Rural valuation represents 66 percent of the total. City and town valuation represents 22 percent of the total. In 1974, the rural/city proportions were 62.6 percent and 26.8 percent respectively, indicating a trend away from new construction in urban centers (Reference 34).

## LAND AND PROPERTY VALUE

Property values in Kitsap County have been rising at an average annual rate of 11 percent in recent years (References 33, 34). This trend is reflected in total county assessed valuations, which are currently at 100 percent of market value. Table 16 presents the increased in value of both existing properties and new construction for the years 1970 through 1975. The assessed value of new construction has increased from $36 million in 1974 to $69 million in 1975, a 93 percent rise. This reflects the influx of Trident personnel and related support employment (Reference 34). Rising property values and increased new construction are expected to continue through the completion of the Trident project.

Sales of existing properties are already occurring at an increasing rate. Although the Trident base will not be completed until late in 1978 (Reference 36), representatives of companies, which will service the facility, are already moving into central Kitsap County, including the Bremerton area. These people are generally more affluent than the Navy personnel and are coming from areas where housing costs are much higher than in Kitsap County. The resultant increased demand for homes has raised the value of existing property. Many local residents are selling property for speculative purposes and relocating to the Port Orchard area, where prices are still relatively low. This secondary effect is creating population pressure south of Sinclair Inlet (References 37, 38).

## BONDED DEBT

In order to finance the local portion of construction costs for the various facilities, it will be necessary to issue revenue bonds. On Table 17 there is a breakdown of the agencies which will contract to the bonding parties to guarantee repayment of their portion of the improvement.

Revenue bonds may be used by an entity to finance major facilities when an adequate method of levying and collection service charges

Table 17. FINANCING AND CONTRACTUAL ARRANGEMENTS

| Bonding Entity | Contracting Agencies | Wastewater Facilities |
|---|---|---|
| Kitsap County | Kitsap County | Manchester |
| City of Port Orchard | City of Port Orchard<br>Sewer District #5<br>(Retsil/Annapolis) | Port Orchard<br>KCSD #5 |
| City of Bremerton | City of Bremerton<br>Kitsap County<br>Sewer District #1 | Charleston<br>Manette |

Source: Reference 39.

to secure payment of the bonds can be developed. Unlike general obligation bonds, payment of revenue bonds is secured solely by the revenues derived from, or as a result of, the improvement constructed with bond proceeds. Because of the increasing difficulties faced by many communities and public agencies attempting to finance an increasing number of services within their general obligation bonding capacity, this type of bond is becoming increasingly popular.

Major advantages of revenue bonds can be summarized as follows: (1) revenue bonds are payable solely from the revenues of the project and can never become a lien or charge against real property; (2) payment of the bonds is derived solely from users of the facilities of the project for which the bonds were issued; and (3) a referendum is not required.

## Kitsap County

The administration of the Manchester facility has recently been taken over by Kitsap County (Reference 36). Previously, improvements had been financed through the establishment of Local Improvement Districts (LIDs) approved by residents of the service area. Property assessments established by an independent engineering firm were used as a basis for direct billing. Some portion of the debt is financed through user charges (Reference 40). A breakdown of the County budget is given in Appendix F.

Outstanding current debt established by these LIDs was $191,000, as of April 1977. Debt service in 1977 will total $22,875, including $13,000 retirement of principal. A reserve fund is maintained which, by covenant, amounts to one year's debt service. There is no minimum ratio for debt coverage.

## City of Port Orchard

The City of Port Orchard will act as fiscal and administrative agent for the construction of improvements at the Port Orchard and Retsil facilities. Kitsap County Sewer District #5 (Retsil/Annapolis) will contract with the City for repayment of its portion of the financing. As of the end of fiscal year (FY) 1976, outstanding issues totalled $502,000. Debt service in 1977 will amount to $51,325, including approximately $19,000 in principal. Revenues are currently covering debt service by a ratio of 2 to 1, although the bond covenant requires only 1.4 to 1. A breakdown of the city budget is given in Appendix F. There are no state or city charter restrictions limiting the Port Orchard City Council in the issuance of revenue bonds (Reference 41).

## City of Bremerton

The bonding entity for construction in the Bremerton system will be the Water/Sewer Fund of the City of Bremerton. It is anticipated that Sewer District #1, Kitsap County, and the City of Bremerton will contract to participate in repayment of the debt. The Water/Sewer Fund reported $4,853,000 in outstanding bond obligations as of December 31, 1976. Total debt service on these issues for fiscal year 1977 will be approximately $346,000, including $109,000 for repayment of principal. A breakdown of the city budget is given in Appendix F.

There is a debt limitation on the Water/Sewer Fund of 5 percent of the applicable assessed valuation, including utilities, which currently allows a margin of debt available of $7.3 million.

User charges are adjusted according to the appropriate departmental expenditures, including salaries, capital costs and debt service. The debt ratio required by covenant on the outstanding issues is 1.4 times the debt service. The 1976 annual report of the City of Bremerton states that the average annual debt service coverage in 1975 was 1.68 (Reference 42).

## UTILITY SERVICES

### Gas

Natural gas is provided to Kitsap County by Cascade Natural Gas Company. Service connections have been limited primarily to the Bremerton and Port Orchard areas.

### Electric Power

Puget Sound Power and Light Company provides electric power to the study area. Since Puget Sound Power and Light Company relies on a hydroelectric-based generating system for 82 percent of its power supply (Reference 43), shortage of electrical energy could result during dry years with low streamflow. At present, there is a voluntary program to reduce consumption by 10 percent in Kitsap County (References 44,45). The company is now moving toward a combination of hydro and thermal power. Its first coal-fired generating plant went into operation in 1975, with a 330,000-Kw capacity. The company's combined capability, including purchases from other systems, stood at 2,900 megawatts at the end of 1975 (Reference 43).

Standby generators at both the Manchester Naval Fuel Depot and the Puget Sound Naval Shipyard (Bremerton) are capable of supplying sufficient power for all operations at those facilities (Reference 46).

### Water Supply

Water in the study area is supplied by several types of systems. Bremerton's primary water source is the Bremerton Watershed, the County's largest single source, with a reserve capacity of 106,000 $m^3$ (28 mil gal.). The Port Orchard system, in comparison, relies primarily on wells and has a reserve capacity of only 133 $m^3$ (35,000 gal.) (Reference 10).

Aside from the city systems, most of the study area's population is served by five local water districts, with a combined reserve capacity of approximately 14,000 $m^3$ (3.7 mil gal.). A small percentage of the population receives water from community systems or from private wells.

## Storm Drain Systems

Less than one half of the developed land within the study area is served by storm drains. Substantial portions of the older storm drain systems were constructed to flow into the sanitary sewer system. These are known as combined sewer overflows (CSO). Where new land development has taken place, or older portions of the system have been upgraded, separate drains have been constructed for storm water and sewage. With a few exceptions, maintenance of drains throughout most of the study area has been fair to poor. Rural areas have no engineered storm drain systems, nor, in most areas are they needed. During periods of heavy runoff, inflow of stormwater causes the treatment plants to exceed their hydraulic capacity and raw sewage is discharged through outfall to marine waters.

Bremerton is presently served by separate systems throughout much of its area; approximately 25 percent of its 180 km [113 mi] of sewer line are combined with storm drains. The Retsil/Annapolis community also has separate drains in most of their system. Port Orchard's two systems are now almost entirely distinct, as a result of a concerted effort in the last five years to prevent inflow of stormwater into the sewage collection systems. The Navy Yard City lines are in fair condition, at best. Kitsap County Airport and the continguous industrial park are served by separate storm drains.

## TRANSPORTATION

Since Kitsap County is located on a peninsula, the Hood Canal Bridge near the northern tip of the peninsula, the bridge to Tacoma on State Highway 16, and the State Ferry System are the main auto access routes to the area. Four ferry terminals at Kingston, Winslow, Bremerton and Southworth connect the County with greater Seattle. Traffic is heaviest on the Winslow run, followed by Bremerton, Kingston and Southworth. The ferries handle 400,000-600,000 passengers and 200,000-330,000 autos per month (Reference 47). Trident construction, increased shipyard activities, and normal growth have accounted for a recent marked increase in ferry passengers and auto traffic (Reference 37). Ferry service is currently operating near or at capacity during peak hours; and, due to lack of funding, no new equipment purchases are foreseen at present.

Major highway routes, as shown in Figure 14, include: State Route (SR) 303 from East Bremerton across Port Washington Narrows to Bremerton; SR 3 which follows along Dyes Inlet through Bremerton along Sinclair Inlet and southwest to the county airport; SR 16 from Gorst south through the Blackjack Creek Valley; and SR 160 which follows along the south shore of Sinclair Inlet through Port Orchard and eastward. Beach Drive runs from Port Orchard eastward along the shore of Sinclair Inlet over to Manchester and along the edge of Puget Sound.

Heavy traffic areas include: portions of downtown Bremerton and Port Orchard; the junction of SR 3 and SR 16 at Gorst, the junction of SR 160 and Beach Drive immediately east of Port Orchard; and perimeter streets along Manette which access bridges crossing the Port Washington Narrows. The most heavily travelled route is SR 3 from Bremerton along Sinclair Inlet to the junction with SR 16 at Gorst. Peak hour traffic volumes approach road capacity and lead to severe congestion. The existing Charleston treatment plant is located within this heavy traffic area near the main intersection where the branch of SR 3 from the shipyard joins the branch of SR 3 from Oyster Bay.

## VISUAL AND AESTHETIC ENVIRONMENT

Visual and aesthetic qualities within the Sinclair Inlet area can be divided into three categories: water-related, urban and rural.

The spatially dominant waterways and passages such as Sinclair Inlet, Port Orchard Bay, Dyes Inlet and Puget Sound constantly present the sights, sounds and smells of the marine environment. The inlets and passages also provide a visual and psychological link with Puget Sound and the ocean. Shoreline areas are considered to have high aesthetic qualities and are typically lined with residences and recreational facilities.

The most visually dominant urban area is Bremerton. The activities associated with the Naval Shipyard present a busy industrial and commercial atmosphere. Probably the most well-known visual landmarks on the ferry approach to Bremerton are the massive hammerhead cranes towering over the shipyard.

Rural areas generally play the largest role in the visual and aesthetic environment. Large stands of Douglas firs, thick brush and ground cover, and open meadow areas provide a natural setting with high aesthetic appeal. Small communities and individual residences generally blend in with the rural setting. The relaxed natural setting has also attracted many city dwellers to this area in more recent years for recreation and homesites.

## RECREATION AREAS

There are four basic types of recreation areas that may be affected by the proposed project. They are: proposed bicycle routes piers and boating facilities, shorelines and marine waterbodies, and parks. The proposed project has the potential to affect the use of these areas by eliminating aesthetic nuisances, improving water quality, creating construction disturbances and expanding existing treatment facilities.

There are two bicycle routes planned for in the Kitsap County Comprehensive Park and Recreation System Plan, which are located in potential project construction and operation areas. The first route is between Retsil and Waterman Point. The second route is through an area of chronic septic tank failure situated between Annapolis and Waterman Point along the shoreline. This area has an Intermediate land use classification assigned by the Kitsap County Comprehensive Plan. As discussed in the Future Land Use Section, this classification calls for the provision of sewerage facilities as development densities warrant them.

Effluent discharges are presently having various degrees of minor to moderate adverse aesthetic effects, thus limiting recreation uses to an undetermined extent, at the Manchester boating pier, the Annapolis pier, the Port Orchard Marina and the boating facilities at Retsil. Also, treatment facilities compete for space with recreation uses at the Port Orchard Marina.

Existing marine water quality in Sinclair Inlet discourages many persons from engaging in activities such as fishing, clamming and beachcombing. The intensity of water-related recreation activities in the Sinclair Inlet system can be affected by changes in water quality brought about by modifications in pollutant discharges to marine waters.

There is a park adjacent to the Manchester Plant and a maintained, open area adjacent to the Retsil plant. Changes in land needs at both plant sites could modify the usable open space of the two parks, thus affecting their attractiveness for recreation activities.

# SECTION III

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# SECTION III

# ALTERNATIVE PLANS

The facilities plan contains provisions for the transport of sewage from sewered population areas, treatment of sewage to levels compatible with receiving water quality criteria, and discharge of treated wastewater to the final disposal sites. Wastewaters would be collected from drainage sub-basins 11, 24, 26, 27 and parts of 23 as shown in Figure 1. Detailed descriptions of the sub-basins are provided in Section II, Environmental Setting.

## DESIGN FLOWS AND QUALITY

The facilities planning consultant has estimated that the study area population will rise from an estimated base of 69,300 in 1975 up to approximately 89,000 persons in the year 2000. In 1975, an estimated 45,000 persons, or 66 percent were served by sewers. By 2000 it has been predicted that 78,000 persons or 88 percent of the population will be connected to the ultimate sewerage system. Sewers will be extended to those areas presently having septic tank failures. Sewer service eventually will be extended to all areas developed to a density of five dwelling units (d.u.)/ ha [2 d.u./ac]. Thus, designated rural areas will not be sewered under present plans, but semi-urban areas will be connected to proposed sewerage facilities when they reach urban densities.

The 20-year design flow for 2000 was estimated at 0.55 $m^3/s$ [12.8 mgd]. This value includes 0.38 $m^3$ [100 gal]/cap.day of groundwater infiltration into sewers and inflow of storm water through openings such as manhole covers. Commercial and institutional flows are estimated to total 0.08 $m^3/s$ [1.82 mgd]. Further details may be found in Appendix H of the facilities plan (Reference 1). The sewer system is not intended to collect storm water runoff, and sewer design would attempt to minimize such inflow. The division of sewage flows in 2000 is estimated to be as follows: Bremerton, Wildcat Lake and Gorst (sub-basins 26) at 0.11 $m^3/s$ [2.6 mgd] and Manchester (sub-basin 27) at 0.03 $m^3/s$ [0.56 mgd].

Wastewaters generated through 2000 are expected to be of typical domestic sewage quality. The facilities planner estimated that the current sewer system receives a flow of 0.31 $m^3$ [80 gal]/cap.day with five-day biochemical oxygen demand ($BOD_5$) and suspended solids loadings (SS) of 0.08 kg [0.17 lb]/cap.day each. For future development, however, the facilities planner developed higher values to reflect

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greater usage of automatic appliances and increased disposal rates. For areas developed after 1975, flow was based on estimates of 0.38 $m^3$ [100 gal]/cap.day and corresponding $BOD_5$ and SS loadings of 0.09 kg [0.20 lb]/cap.day each. A graphical presentation of untreated waste loads generated by the planning area is shown in Figure 15. Typical domestic wastewater presents no problems to the standard sewage treatment processes.

Commercial contributions to the system will generally be low. Commercial flows originate primarily from Bremerton and Port Orchard and will comprise approximately eight percent of the total flow.

Industrialization within the study area consists of the Puget Sound Naval Shipyard, the Manchester Fuel Depot and the Olympic View Industrial Park/Kitsap County Airport. The design year flows and waste loads take into account three new special waste treatment/collection systems under construction. The first two are at Puget Sound Naval Shipyard and the third will be at the Manchester facility. The first is an industrial waste treatment system to be completed in 1977 with a small 0.003 $m^3/s$ [0.072 mgd] flow to the Bremerton system. The second is a ship waste collection system to be completed in 1979 with a 0.035 $m^3/s$ [800,000 gal/day] flow to Bremerton. The third new system at the Manchester Naval Fuel Depot will be a ship waste collection system and an oily waste separator system operating by 1980. Only the ship waste collection system with a holding tank of 715 $m^3$ [189, 000 gal] will be discharged to the Kitsap County Sanitation District (KCSD) No. 3 (Manchester system). Flows from the Olympic View Industrial Park/Kitsap County Airport will be relatively small and will probably continue to be treated by the existing small treatment lagoon and drainfield system.

Infiltration and inflow (I/I) exist to some degree in every sewerage system in the area. The flows used herein for developing design data assume the cost-effective removal of excessive I/I. In KCSD No. 3, whether I/I is excessive depends on the alternative selected. The facilities planner has assumed probable removal of I/I. However, the magnitude of these flows is not significant enough to affect the choice of alternatives in the later phases of analysis.

## ALTERNATIVE STRATEGIES

Discharge strategies are general approaches to wastewater treatment and disposal, and are described in terms of discharge location and effluent quality. Within each strategy, several alternatives are usually possible for meeting discharge requirements. For the Sinclair Inlet study, four action strategies were developed, plus the fifth strategy of no action. For the four action strategies, existing com-

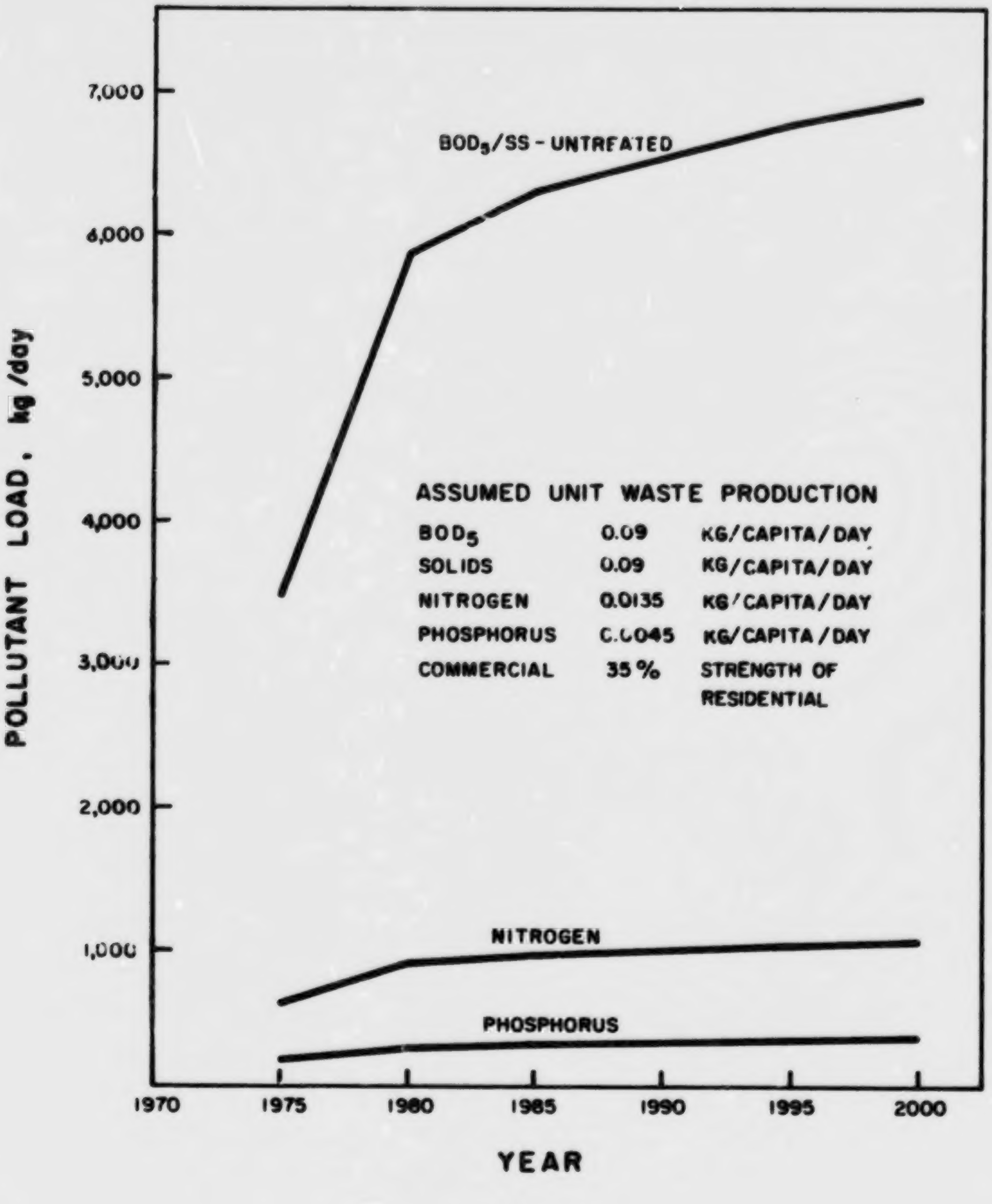


FIGURE 15 ESTIMATED UNTREATED WASTE LOADS

bined sewer overflows that have detrimental effects on the use of receiving waters will be controlled to reduce these impacts to acceptable levels. Excessive infiltration/inflow will also be removed from the systems.

### Discharge to Sinclair Inlet

The main discharge area with this strategy would be Sinclair Inlet and/or Port Washington Narrows. Under this strategy, five alternatives were defined. Potential treatment sites and features are shown in Table 18. The alternatives ranged from upgrading all existing plants to secondary treatment with individual outfalls, to regional treatment plants at Charleston or Manchester.

### Discharge to Port Orchard Bay

The major discharge in this strategy would be to Port Orchard Bay either from the Bremerton side or the Waterman side. This strategy would likely result in a regionalization of the area's sewerage system. All discharges would receive secondary treatment. The two alternatives possible with this strategy are presented in Table 18.

### Discharge at Manchester

The major discharge with this strategy would be to Puget Sound. A single treatment plant, requiring regionalization, would serve the study area under this strategy. Primary treatment, although currently an unacceptable treatment level for discharge to receiving water, was considered by the facilities' planner for comparison purposes. The alternatives possible with this strategy are defined in Table 18.

### Nutrient Removal

With this strategy algae stimulating nutrients would be removed from the treated wastewaters either by advanced waste treatment (AWT) or land treatment of effluent. Nutrient removal processes are relatively expensive compared to primary and secondary treatment. To be cost-effective, a main regional treatment facility would be required with this strategy. Due to the small volume and cost-effectiveness reasons, the Manchester facility would be upgraded to the secondary level and remain independent. The two alternatives considered are shown in Table 18.

## Table 18. WASTEWATER TREATMENT AND DISPOSAL, STRATEGIES AND ALTERNATIVES

| Strategy | Plan number | Treatment sites | Discharge sites | Features |
|---|---|---|---|---|
| Discharge to Sinclair Inlet | 1 | Charleston<br>Port Orchard<br>Retsil<br>Manchester | Sinclair Inlet<br>Sinclair Inlet<br>Sinclair Inlet<br>Puget Sound | All of Bremerton's wastewater will receive secondary treatment at Charleston. Port Orchard, Retsil and Manchester will maintain individual secondary treatment plants discharging to Port Orchard Bay and Puget Sound, respectively. |
| | 2 | Charleston<br>Retsil<br>Manchester | Sinclair Inlet<br>Sinclair Inlet<br>Puget Sound | This alternative differs from Sinclair Inlet Alternative 1 in that Port Orchard and Retsil join in a single secondary treatment plant at Retsil. |
| | 3 | Charleston<br>Manchester | Sinclair Inlet<br>Puget Sound | Port Orchard and Retsil would consolidate their sewerage systems at a secondary treatment facility at Charleston. Transmission costs to a central treatment facility are lowest with the Charleston location. The Manchester facility remains independent. |
| | 4 | Manette<br>Charleston<br>Port Orchard<br>Retsil<br>Manchester | Port Washington Narrows<br>Sinclair Inlet<br>Sinclair Inlet<br>Sinclair Inlet<br>Puget Sound | All existing plants will be upgraded to secondary treatment capacity and expanded as necessary at their present locations. Pumping and transmission line costs are lowest with this system. |
| | 5 | Charleston<br>Manchester | Sinclair Inlet<br>Puget Sound | Regional treatment facilities will serve the north and south sides of Sinclair Inlet at Charleston and Manchester, respectively. Port Orchard and Retsil are served at Manchester. |
| Discharge to Port Orchard | 1 | Waterman<br>Manchester | Port Orchard<br>Puget Sound | A new regional treatment facility will be constructed with a discharge at the junction of Rich Passage and Port Orchard Bay. The discharge location has good mixing properties and would be outside of Sinclair Inlet. |
| | 2. | Enetal<br>Retsil<br>Manchester | Port Orchard<br>Port Orchard<br>Puget Sound | Regional treatment facilities at Retsil (serving Port Orchard and Retsil) and Enetal (serving Bremerton) will discharge into Port Orchard Bay. Manchester remains independent. |
| Discharge at Manchester | 2 | Manchester | Puget Sound | A regional facility serving the entire study area will be constructed at Manchester. In addition to secondary treatment, primary treatment is considered. with a deep-water discharge. |

## Table 18. (Cont'd) WASTEWATER TREATMENT AND DISPOSAL, STRATEGIES AND ALTERNATIVES

| Strategy | Plan number | Treatment sites | Discharge sites | Features |
|---|---|---|---|---|
| | 4 | Manchester | Puget Sound | Central Kitsap County will share secondary treatment facilities with Sinclair Inlet at a new regional plant in Manchester. Flows and the attendant transmission costs will be much greater. |
| Nutrient Removal | 1 | Charleston<br>Manchester | Sinclair Inlet<br>Puget Sound | A regional facility serving all areas except Manchester, will be constructed at Charleston. In addition to secondary treatment, nitrogen will be removed from wastewater to reduce algae stimulation in Sinclair Inlet. The Manchester facility remains independent. |
| | 3 | Charleston<br>Retsil<br>Manchester | Land application south of Long Lake<br>Puget Sound | Charleston is upgraded to secondary treatment. Port Orchard consolidates with Retsil which is upgraded to secondary treatment also. Effluent from both plants is pumped to a land application site south of Long Lake. The Manchester facility remains independent. Groundwater supplies will be recharged with high quality renovated water and Sinclair Inlet water quality will be protected from effluent discharges. |

## Advanced Wastewater Treatment (AWT)

The secondary treatment processes at the regional plant would be supplemented by new facilities to remove nitrogen from wastewaters. Nitrogen contributed from wastewater effluent can overstimulate algal growth in marine waters. AWT processes can reduce nitrogen, generally in the forms of ammonia-nitrogen and nitrate-nitrogen, by 95 percent through mechanical and biological processes. However, AWT systems entail high capital costs, are extremely energy intensive and performance has not been documented over long periods of time for large systems. Where possible, land treatment of wastewaters - which usually involves lower capital costs and energy usage - is often considered desirable.

## Land Treatment of Wastewater

Nutrient removal strategy alternative No. 3 considered land treatment of effluent. Land application of wastewater is highly dependent upon local climatic conditions, soils type and the quality and quantity of wastewater. This technique uses the assimilative capacity of plants, the soil surface and the soil matrix to remove nutrients and other constituents from the wastewater. Usually some degree of pretreatment is required before the wastewater is applied to land. Two types of land application were analyzed for the study area: irrigation and infiltration-percolation. The assumed flow was 0.52 $m^3/s$ [12.0 mgd].

**Land Treatment by Irrigation**. The irrigation method uses wastewater to supply the water requirements for crops. Due to the rainy climate, the annual net irrigation requirement is only 13 cm [5.1 in.] compared to 100-125 cm [40-50 in.] in a dry climate. With low irrigation requirements, large amounts of land will be needed to handle 0.52 $m^3/s$ [12.0 mgd]. Disposal of the wastewater through the irrigation method would require approximately 8500 ha [21,000 ac]. Within the study area, the Everett gravelly sandy loam (Ev) is the most suitable for this method of application. However, according to Soil Conservation Service (SCS) personnel, there is no contiguous area of Everett soils of this size within or near the study area; therefore, this method of application was eliminated from further consideration.

**Land Treatment by Infiltration/Percolation**. The infiltration-percolation process involves high loadings of wastewater and uses the capacity of crops to remove nutrients to only a limited extent. In forested areas, the natural vegetation may die under the high application rates used in this method. Without vegetation, the uptake of nutrients will be lessened. If there are strict limitations on discharge of nutrients into the groundwater, this process may become infeasible, depending on the assimilative capacity of the soils.

Two rates of application were reviewed for the infiltration-percolation method: (1) low (5 cm [2 in.] per week total wastewater + precipitation) and (2) high (25 cm [10 in.] per week total wastewater + precipitation). Both of these application rates would require storage to hold the wastewater during periods of intensive rainfall when wastewater could not be applied.

The Everett gravelly sandy loam (Ev) was determined to be the most suitable soil for the low rate infiltration-percolation process and would require approximately 1,000 ha [2,500 ac] to accommodate projected flows. Because of the small contiguous acreage of this soil type available near the study area, low rate-infiltration-percolation was eliminated from further consideration.

The high rate infiltration-percolation process requires approximately 138 ha [340 ac] of suitable soil with an additional 32-40 ha [80-100 ac] for attendant uses. The Everett gravelly sandy loam (Ev) was also determined to be the most suitable soil for this method of application. By using available SCS soil mapping, one contiguous area of Everett gravelly loamy sand (Eg) was identified south of the Long Lake area.

## No Action Strategy

The facilities plan also examined the option of continuing present operations with no changes. Currently, the existing treatment facilities in the Sinclair Inlet area do not meet state and EPA standards. In addition, discharges and overflows into the inlet seasonally degrade the bacteriological quality of Sinclair Inlet to below Class A standards, causing a ban on shellfish harvesting in the area. These conditions could only be expected to worsen as flows from the area increase, causing further degradation of the water quality of Sinclair Inlet. For these reasons, the no action alternative was considered unacceptable by the facilities planner.

## Strategy Evaluation by the Facilities Plan

The facilities plan evaluated each strategy primarily on the basis of cost-effectiveness and comparative improvements effected upon the local water quality. Projected water quality improvements were analyzed with the aid of the Ecologic Model of Puget Sound as developed for EPA. The model was calibrated for Port Orchard and Sinclair Inlet conditions for the years 1980 and 2000. Modelled parameters focused on dissolved oxygen, nutrients and algal concentrations. The following model runs were made on a coarse grid:

1) Existing Conditions: primary treatment facilities at Manette, Charleston, Port Orchard, Annapolis and Manchester;

2) Sinclair Inlet Discharge Strategy: Secondary treatment facilities at Charleston and Manchester for 1980 and 2000. This strategy was also modeled with a fine grid;

3) Port Orchard Bay Discharge Strategy: Secondary treatment facilities at Enetai and Manchester for 1980 and 2000;

4) Nutrient Removal Strategy: AWT at Charleston and Secondary treatment at Manchester for 1930 and 2000.

The Manchester regional discharge strategy was discarded from consideration due to its high cost, the high degree of local cooperation required and the fact that Central Kitsap County will be constructing a separate treatment facility in the near future. The strategy involving no marine discharge with land treatment-nutrient removal was evaluated to be similar to AWT-nutrient removal in terms of nitrate effects on waters. Since the model was run primarily to simulate algal growth in Sinclair Inlet, only the reduced nitrogen condition in AWT was computed.

The results of the computer runs indicated that only small incremental improvements in Sinclair Inlet water quality were achieved over present conditions with secondary-treated effluent outfalls in either Port Orchard Bay or Sinclair Inlet. Similar slight benefits also resulted with the nutrient removal strategy.

According to the ecological model, algae blooms would continue to occur annually in Sinclair Inlet. Secondary treatment does not remove nutrients; therefore, algal activity would increase slightly (less than 10 percent of measured chlorophll a) with increased wastewater flows. With the nutrient removal strategy, algal activity was projected to be less than that with secondary-treated effluent and approximately equal to present levels of algal activity in Sinclair Inlet. Thus, nutrient removal would allow Sinclair Inlet to retain approximately the same or a small percentage higher algal activity. The Port Orchard Bay discharge, Manchester discharge and nutrient removal strategies in each case were more energy intensive and costly than the Sinclair Inlet discharge strategy and thus were eliminated from further consideration.

Based primarily upon these evaluation, the facilities planner recommended the Sinclair Inlet discharge strategy. This strategy was the least expensive, while providing water quality capable of meeting "A" standards. Although Sinclair Inlet is a shallow embayment with a slow flushing rate, it was envisioned to have adequate dilution volume for wastewater discharges. The higher degree of treatment would also produce a lower unit wasteload thus improving present water quality. Also, the proximity of the inlet to the major population concentrations in the planning area made it a prime location for effluent discharge.

Under the Sinclair Inlet discharge strategy, four of the five alternatives initially proposed were examined in greater detail in order to select a preferred alternative. The first alternative as described in Table 18, was eliminated immediately because all reasonable treatment options for each entity could be described by the remaining four alternatives.

## Alternative Plans - Sinclair Inlet Discharge Strategy

### Alternative 1 (No Action)

For the purpose of this EIS, Alternative 1 was defined as the no action alternative. The five existing primary treatment facilities and marine outfalls as described in the "Present Status" section would be retained. As each facility is presently at or above its capacity, future connections to the sewer system and expansion of the service area would be greatly limited. Installation of septic tanks and leach fields for new structures would be evaluated on an individual basis by the County Health Department. Associated with this alternative would be the continuation of periodic septic system failures and pollution of shallow groundwater aquifers.

### Common Features - Alternatives 2-5

Alternatives 2-5 have a number of common features, namely:

1. The Port of Bremerton will continue to operate a separate treatment facility serving the Kitsap County Airport and the Olympic View Industrial Park. The Port currently has the only secondary treatment facility in the area and the system appears to perform satisfactorily. The flow from the port is small and the cost of pumping it to another facility in the area would be high.

2. KCSD No. 3 (Manchester) will be served by a treatment facility in the vicinity of Manchester. This is because Manchester

is separated by 6 km [4 mi] of hilly terrain from the center of the study area population, which makes pumping and pipeline costs very high. Also, the assimilative capacity of the local receiving waters (Puget Sound) off Manchester is higher than that of any other locations, providing adequate dilution and dispersion.

3. At present, Sinclair Inlet is a Class A water with a special condition allowing higher-than-normal coliform level. Upgrading treatment levels to secondary treatment should cause more effective solids removal, thereby allowing more effective disinfection. Also, elimination of serious overflows and bypasses presently discharging into Sinclair Inlet and Port Washington Narrows would remove major sources of fecal contamination. Thus all alternatives will remove the special discharge condition from the Class A rating of Sinclair Inlet and Port Washington Narrows.

4. Excessive infiltration/inflow will be removed from the sewer systems in the study area. Preliminary evaluations of the sewer systems have indicated excessive infiltration/inflow in many areas, which will be removed before any treatment facilities are designed.

5. Bremerton must agree to serve KCSD No. 1 and all entities must agree to serve undeveloped areas draining to their facilities. Thus, Gorst and other areas are projected to be sewered by the year 2000.

6. Wastewater solids (sludge) from each facility, will be dewatered in covered drying beds at each site and disposed to a private or county landfill. Hauling of liquid sludge for reuse on land applications was considered cost-effective within a 32-km [20 mi] haul distance for Charleston and a 20-km [12 mi] haul distance for Retsil and Manchester. Land application would be an attractive alternative if an acceptable agreement can be reached with a local landowner(s) to handle the material.

## Alternative 2 (Charleston Regional/Retsil Regional/Manchester)

The treatment plant locations and pipeline routes in Alternative 2 are depicted in Figure 16. With this alternative, three treatment plants will be operated: a 0.42 $m^3/s$ [9.8 mgd] facility at Charleston; a 0.08 $m^3/s$ [1.9 mgd] plant at Retsil, both discharging to Sinclair Inlet; and a 0.02 $m^3/s$ [0.5 mgd] plant at Manchester, discharging to Puget Sound. The existing treatment plant at Charleston will be upgraded to secondary treatment and expanded to the design capacity in order to handle all of the flow diverted from the Manette plant. The existing Manette facility will probably be retained in the event that additional capacity is needed in the future. From the Manette pumping station across Port Washington Narrows, wastewater will flow

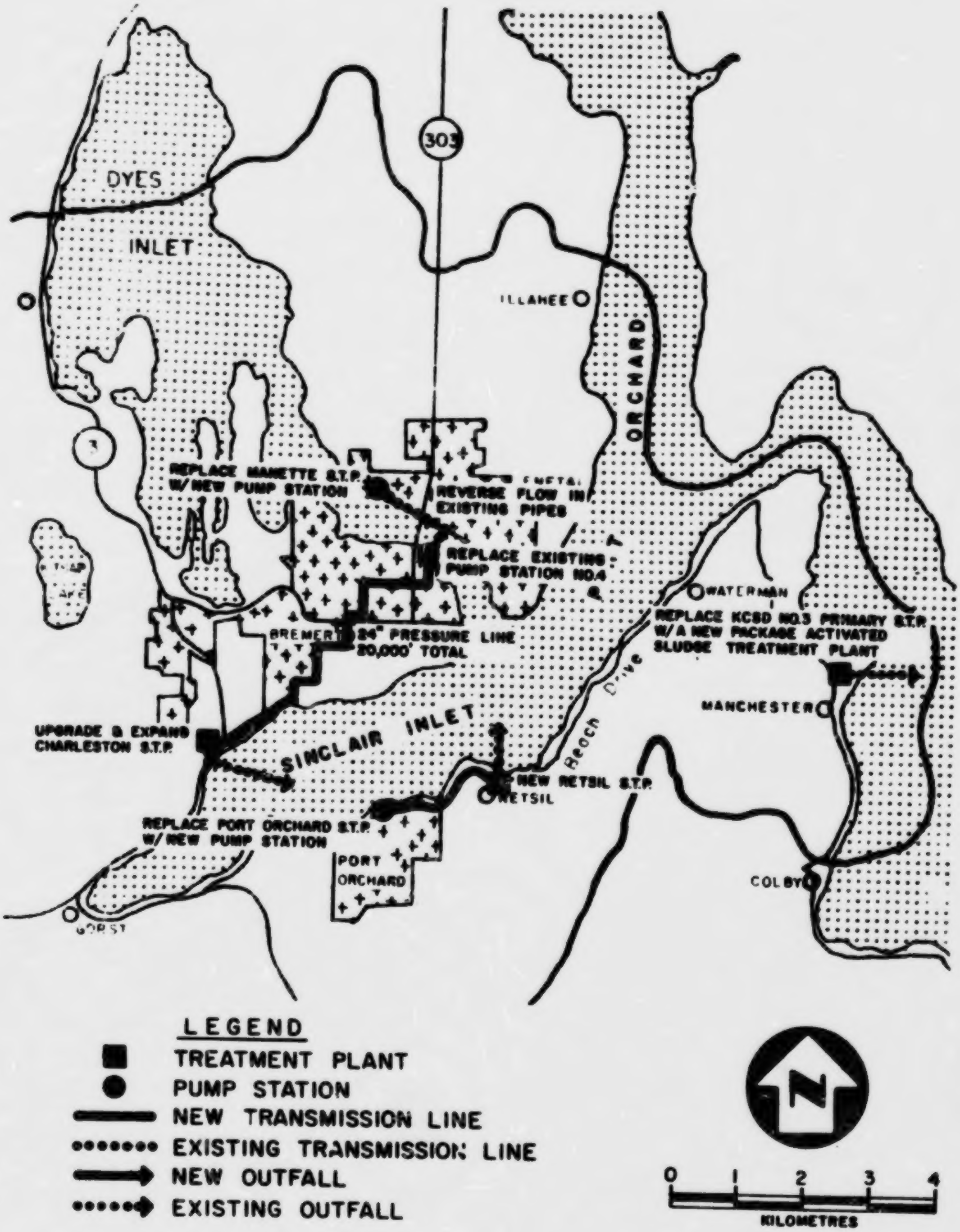

DYES
INLET
303
ILLAHEE
ORCHARD
REPLACE MANETTE S.T.P. W/NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P. W/A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
BREMERTON
24" PRESSURE LINE 20,000' TOTAL
MANCHESTER
UPGRADE & EXPAND CHARLESTON S.T.P.
SINCLAIR INLET
Beach Drive
NEW RETSIL S.T.P.
RETSIL
REPLACE PORT ORCHARD S.T.P. W/NEW PUMP STATION
PORT ORCHARD
COLBY
GORST
LEGEND
■ TREATMENT PLANT
● PUMP STATION
NEW TRANSMISSION LINE
EXISTING TRANSMISSION LINE
NEW OUTFALL
EXISTING OUTFALL
N
0 1 2 3 4
KILOMETRES

FIGURE 16 ALTERNATIVE 2

through the existing pipeline; however, new pipeline construction will be required through the City of Bremerton to the Charleston Plant. The pipeline will be a force main 6 km [3.8 mi] long. The cross-city pipeline route, as shown in Figure 16 is approximate and subject to revision by the facilities planner. The plant site at Charleston presently occupies 2.24 ha [5.52 ac] and will require approximately an addition 1.94 ha [4.8 ac].

The plant at Retsil will also be upgraded to secondary treatment, and will treat all flows from Retsil and Port Orchard. The existing facility at Port Orchard will be removed and a pump station will be built at that site to pump all flows through a force main 2.4 km [1.5 mi] long to the Retsil plant. The pipeline route will be constructed across the intertidal beach. The Retsil plant site currently covers 0.38 ha [0.94 ac] and will need an additional 0.60 ha [1.47 ac].

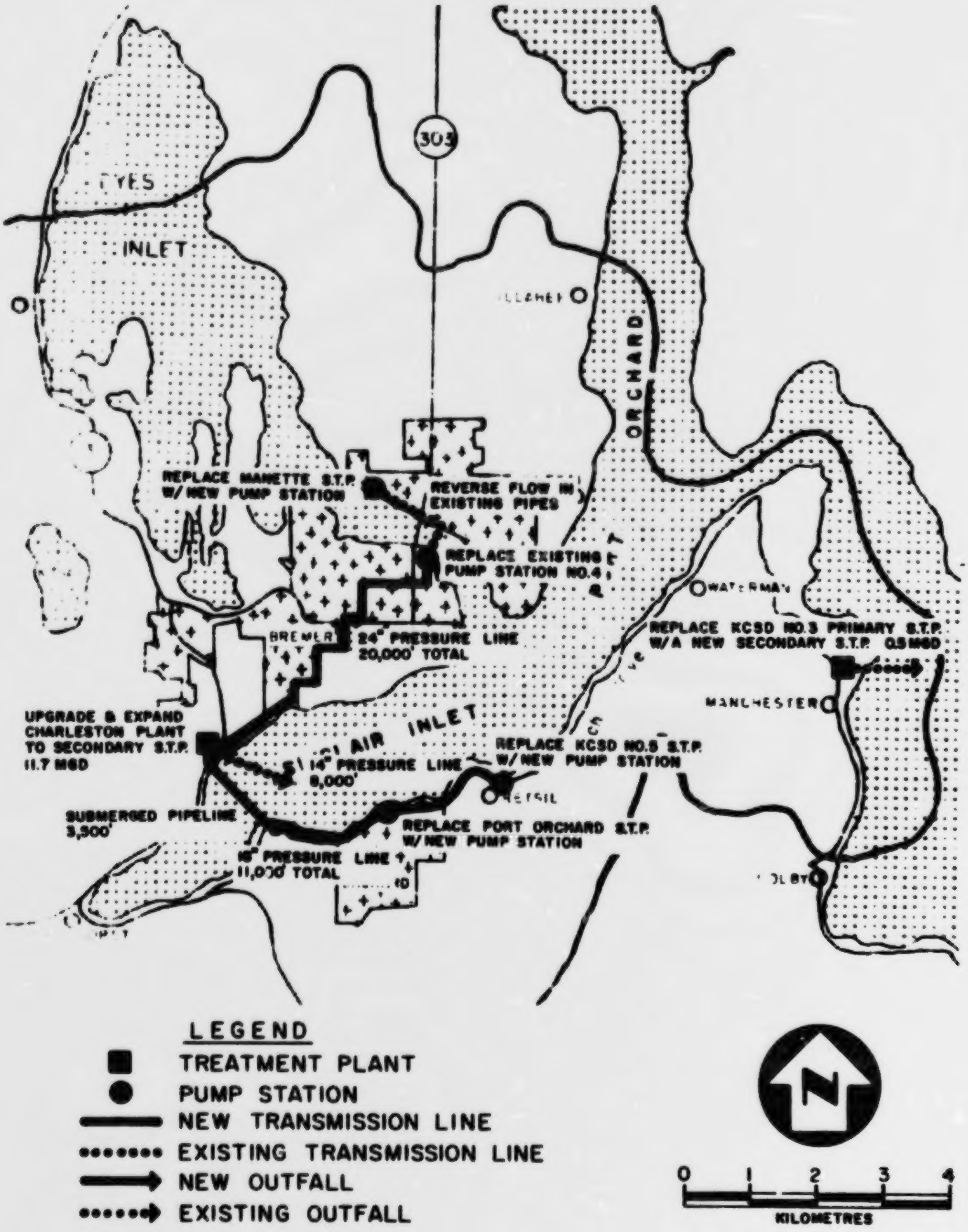
The existing Manchester plant will probably be replaced by a package system or custom-built secondary treatment facility. The plant site currently occupies 0.63 ha [1.55 ac] and will require an additional 0.31 ha [0.76 ac] of land. This alternative requires Port Orchard and KCSD No. 5 (Retsil) to negotiate an interlocal agreement on joint treatment.

### Alternative 3 (Charleston Regional/Manchester)

With Alternative 3, the Charleston plant will be expanded to 0.51 $m^3/s$ [11.7 mgd] and will treat all wastes from Bremerton, Port Orchard and Retsil. The Manchester plant will be enlarged to 0.022 $m^3/s$ [0.5 mgd] with an outfall to Puget Sound. This alternative is shown in Figure 17. Both plants will be upgraded to secondary treatment.

This alternative requires replacing the present plants at Manette, Retsil and Port Orchard with pumping stations and constructing force mains to transport wastewater to the Charleston plant. The existing Manette facility may be retained for future additional capacity. A 6 km [3.8 mi] pipeline across Washington Narrows and through Bremerton will convey wastewater from Manette, and a 5.3 km [3.3 mi] pipeline will be built from Retsil through Port Orchard and across Sinclair Inlet at Ross Point to the Charleston plant. Portions of this pipeline may be built onshore or across the intertidal beach offshore. Expansion of both the Charleston and Manchester plants will require the same amount of land as in Alternative 2.

To implement this alternative, Port Orchard, KSCD No. 5 and Kitsap County must negotiate an interlocal agreement on treatment with Bremerton.


303
DYES
INLET
ILLAHEE
ORCHARD
REPLACE MANETTE S.T.P. W/ NEW PUMP STATION
REVERSE FLOW IN EXISTING PIPES
REPLACE EXISTING PUMP STATION NO.4
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P. W/A NEW SECONDARY S.T.P. 0.5 MGD
BREMERTON
24" PRESSURE LINE 20,000' TOTAL
MANCHESTER
UPGRADE & EXPAND CHARLESTON PLANT TO SECONDARY S.T.P. 11.7 MGD
SINCLAIR INLET
14" PRESSURE LINE 8,000'
REPLACE KCSD NO.5 S.T.P. W/ NEW PUMP STATION
RETSIL
SUBMERGED PIPELINE 3,300'
REPLACE PORT ORCHARD S.T.P. W/ NEW PUMP STATION
16" PRESSURE LINE 11,000 TOTAL
COLBY
LEGEND
■ TREATMENT PLANT
● PUMP STATION
NEW TRANSMISSION LINE
EXISTING TRANSMISSION LINE
NEW OUTFALL
EXISTING OUTFALL
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KILOMETRES

FIGURE 17 ALTERNATIVE 3

## Alternative 4 (Local Treatment Plants)

Alternative 4 retains all of the existing plant sites. Charleston, Retsil, Manchester, Manette and Port Orchard will all be upgraded to secondary treatment. The Charleston plant will have a capacity of 0.26 $m^3/s$ [5.9 mgd]. The Charleston, Port Orchard and Retsil plants all discharge to Sinclair Inlet, Manette discharges to Port Washington Narrows and Manchester discharges to Puget Sound. This alternative is depicted in Figure 18.

All the plant sites except the Charleston site will need additional land. The Manette plant will require an additional 2.3 ha [5.7 ac] for a total of 2.8 ha [6.9 ac]; the Retsil plant will need 0.6 ha [1.4 ac] for a total of 2 ha [5.0 ac]; the Port Orchard plant will need 0.5 ha [1.2 ac] for a total of 0.5 ha [1.3 ac]; and the Manchester plant will need 0.3 ha [0.8 ac] for a total of 1.0 ha [2.4 ac]. No pipelines, other than new collection sewers for newly developed areas, will be constructed under this alternative.

No interlocal treatment agreements are required with this alternative. Sludge will be disposed to the county landfill unless a local landowner, as described earlier, is willing to accept the material.

## Alternative 5 (Charleston Regional/Manchester Regional)

Alternative 5 involves the use of two secondary treatment plants; one at Charleston and one at Manchester. The Charleston plant will by a 0.43 $m^3/s$ [9.8 mgd] facility discharging to Sinclair Inlet, and will treat all wastes from Bremerton. The Manchester regional plant will treat the wastewaters from Retsil, Port Orchard and Manchester. It will be a 0.105 $m^3/s$ [2.4 mgd] plant discharging to Puget Sound. This alternative is depicted in Figure 19.

Additional land will be required by both plants for their expansions. The Charleston plant will require an additional 1.3 ha [3.2 ac]. The Manchester plant will require an additional 0.97 ha [2.4 ac]. Two new force mains will be required: the first, a 6 km line [3.8 mi] line from the current Manette plant site through Bremerton to the Charleston plant; the second a 7.4 km [4.6] line from Port Orchard through Retsil to the Manchester plant. The second pipeline has been proposed to be either constructed onshore, offshore across the intertidal beach, or a combination of the two. Pump stations will be constructed at the sites of the present Manette, Port Orchard and Retsil treatment plants. The primary facilities at the latter

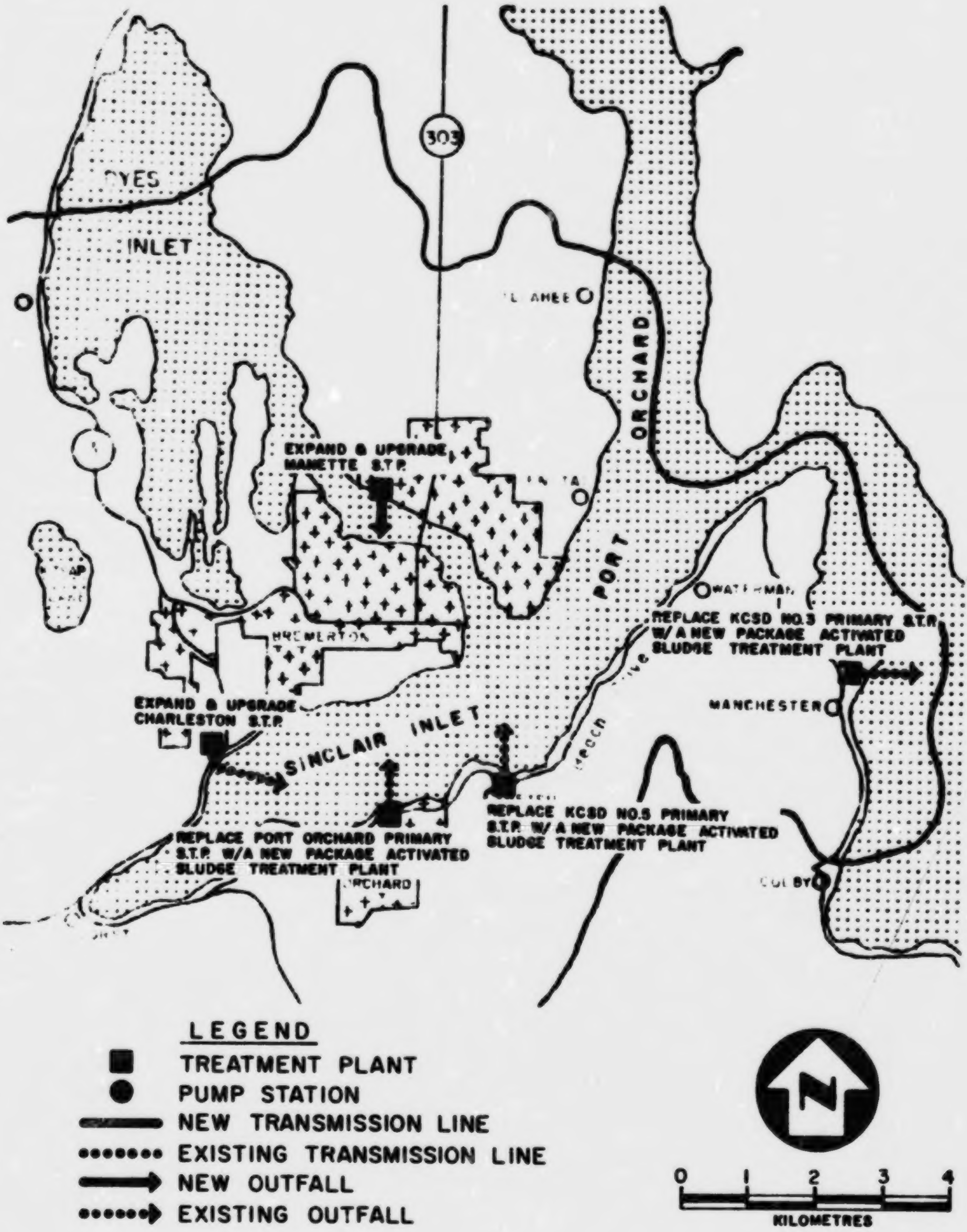
DYES
INLET
303
ILLAHEE
PORT
ORCHARD
EXPAND & UPGRADE MANETTE S.T.P.
BREMERTON
EXPAND & UPGRADE CHARLESTON S.T.P.
SINCLAIR INLET
WATERMAN
REPLACE KCSD NO.3 PRIMARY S.T.P. W/ A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
MANCHESTER
REPLACE KCSD NO.5 PRIMARY S.T.P. W/ A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
REPLACE PORT ORCHARD PRIMARY S.T.P. W/A NEW PACKAGE ACTIVATED SLUDGE TREATMENT PLANT
ORCHARD
COLBY
LEGEND
TREATMENT PLANT
PUMP STATION
NEW TRANSMISSION LINE
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FIGURE 18 ALTERNATIVE 4

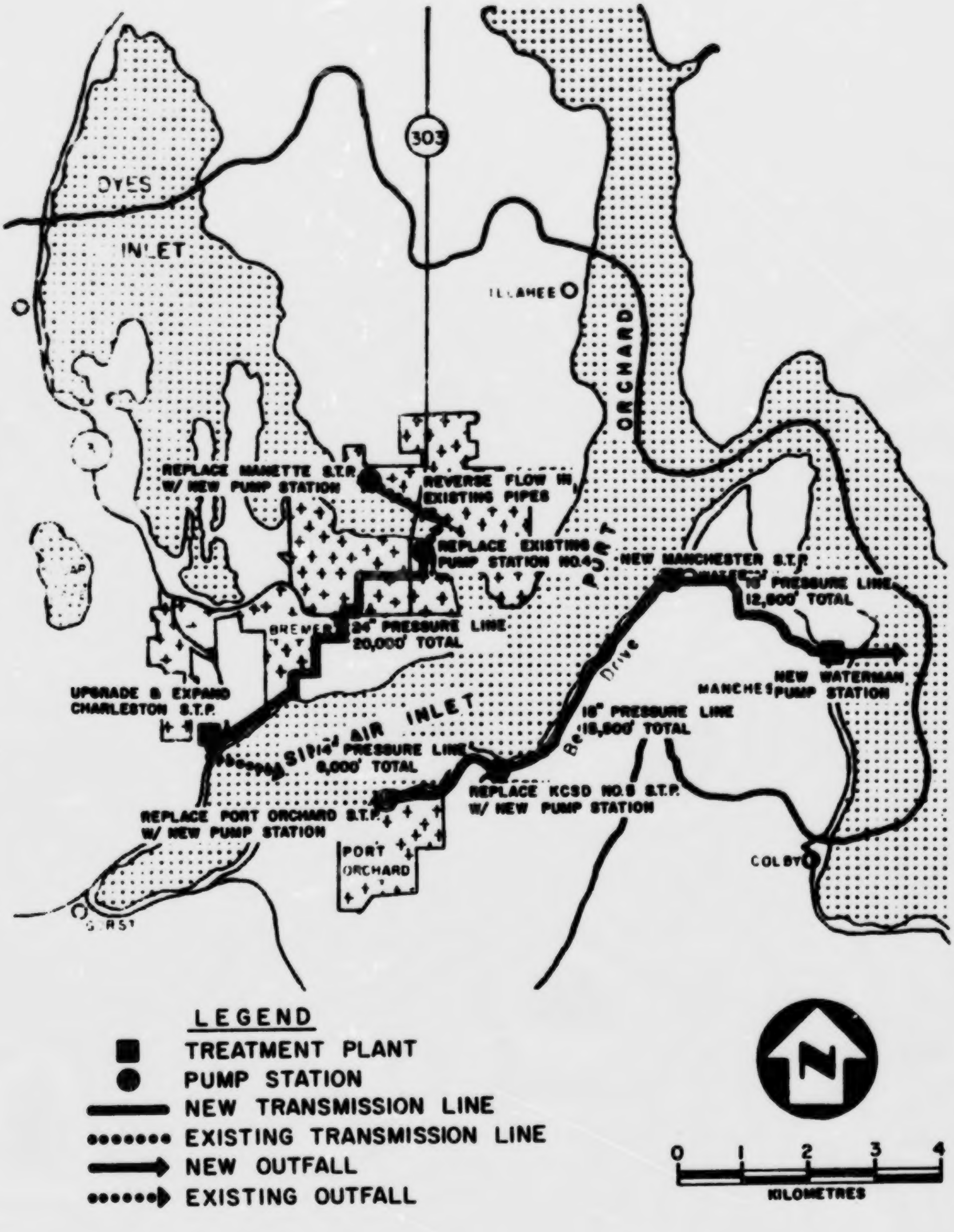
303
DYES
INLET
ILLAHEE
PORT
ORCHARD
REPLACE MANETTE S.T.P.
W/ NEW PUMP STATION
REVERSE FLOW IN
EXISTING PIPES
REPLACE EXISTING
PUMP STATION NO.4
NEW MANCHESTER S.T.P.
16" PRESSURE LINE
12,800' TOTAL
BREMERTON
24" PRESSURE LINE
20,000' TOTAL
UPGRADE & EXPAND
CHARLESTON S.T.P.
SINCLAIR INLET
14" PRESSURE LINE
8,000' TOTAL
Beach Drive
16" PRESSURE LINE
15,800' TOTAL
MANCHESTER
NEW WATERMAN
PUMP STATION
REPLACE PORT ORCHARD S.T.P.
W/ NEW PUMP STATION
REPLACE KCSD NO.5 S.T.P.
W/ NEW PUMP STATION
PORT
ORCHARD
COLBY
GORST
LEGEND
TREATMENT PLANT
PUMP STATION
NEW TRANSMISSION LINE
EXISTING TRANSMISSION LINE
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FIGURE 19 ALTERNATIVE 5

two sites will be removed. An additional pump station will be constructed at Waterman.

Port Orchard and KCSD No. 5 must negotiate an interlocal agreement on treatment with Kitsap County in order to implement this alternative. All sludge disposal will be to the existing landfill at the county airport until the new county landfill at Mansford Road can accept it. Alternate arrangements for sludge recycling, as described earlier, can be made if an interested recipient can be found within a 32 km [20 mi] haul distance of Charleston and another within a 20-km [12 mi] haul distance of Manchester.

## Site Descriptions for Proposed Facilities

### Proposed Treatment Plant Sites

Charleston. The existing site lies at the confluence of the Old Navy Yard Highway and the new section of Highway 3, approximately 2 km from Bremerton. Hillside grading has terraced the original gully terrain into a valley with two troughs. The two sides of the valley are disproportionate in height, with the existing treatment plant lying in the lower trough and the highway overlooking it to the east. The Charleston facility was constructed over dirt fill material.

Along the western edge of the site lies a small creek which is wooded along the western side. The wooded area is characterized by second-growth vegetation and is predominately Douglas-fir and mixed conifers with evergreen shrubs forming the understory. Slope increases rapidly forming a precipitous ridge some 32 m [100 ft] high making the western 0.8 ha [2 ac] of the site unusable.

To the west and north, twenty-one residences exist in the vicinity of the treatment plant. Six residences are within the treatment plant expansion site. Immediately to the south and also within the plant expansion site is a small building maintained by the Society for the Prevention of Cruelty to Animals (SPCA). Sinclair Inlet lies approximately 320 m [1000 ft] downhill from the Charleston Plant. Access to the site is via Highway 3. This portion of the Highway between Navy Yard City and Gorst is one of the most heavily travelled and congested roads in the study area.

The Charleston site includes a small sludge-dewatering lagoon. Digested sludge from the Charleston and Manette facilities is placed in a well-screened area behind the Charleston plant. The dewatered sludge is then trucked to a landfill. In recent years, a private operator has been combining a portion of the sludge with wood chips and using the material as a soil amendment. Few odor complaints have been made about the sludge handling process. The lagoon and sludge/wood chip mixing area will be eliminated with the plant expansion.

Manette. The existing site is located in East Bremerton just to the west of the Washington Narrows Bridge. Situated within a city park on the edge of a developed residential/commercial community, the site has extensive grassy plots and a few shrubs. Few trees screen the plant from the service road, the Highway 303 Bridge or Port Washington Narrows. A residential neighborhood surrounds the park except on the south-west side which slopes down approximately 50 m [160 ft] directly to Port Washington Narrows. Expansion of the treatment plant, under Alternative 4, would involve the removal of up to 25 houses and reduction of the park area. The site is on an excavated shelf which may require further grading for plant expansion.

Port Orchard. The present facility is situated in downtown Port Orchard at the site of the City's marina and boat dock on Sinclair Inlet. The structure housing the treatment plant is on pilings some 5 m [15 ft] above the water's edge at low tide.

Extensive fill operations have greatly altered the natural environment. The shoreline contour has been extended by the construction of a commercial area over a 0.4-0.8 ha [1-2 ac] filled area at the foot of the marina. The sides of the fill have been stabilized with riprap. Little natural vegetation is present along the bay but many aquatic organisms have colonized the pilings and riprap. There is little vegetation screening the treatment plant, however, the exterior appearance has been constructed to appear like other commercial structures in the area. The plant is visible both from downtown Port Orchard and Sinclair Inlet.

The treatment plant is less than a block from the major business street of the town, Bay Street or Highway 160. Expansion of the facility would require 5100 $m^2$ [55,000 sq ft] of adjacent commercial space, which is presently a parking lot. Approximately 1400 $m^2$ [15,000 sq ft] of commercial development surrounds the expansion site.

Retsil. The present 0.4-0.8 ha [1-2 ac] site is approximately 1 km [1 mi] east from Port Orchard on Highway 160 or Beach Drive. Sinclair Inlet lies approximately 24 m [80 ft] to the north. The plant is set back approximately 15 m [50 ft] from the road and is constructed over fill material. The Retsil Veteran's Home is situated upon a promontory to the west and overlooks the Retsil plant. Residential homes border the plant to the east. To the south, Annapolis Creek flows through a wooded canyon composed of mixed Douglas-Fir and broadleaf trees and empties into Sinclair Inlet through a culvert approximately 6 m [20 ft] south of the plant. Some trees and shrubs line the stream. The area around the treatment plant is also landscaped with grass, shrubs and small trees, thus achieving a little screening. Nevertheless, the plant is visible from Sinclair Inlet, Beach Drive, the Veteran's Home and surrounding residences.

Expansion of treatment facilities would require property acquisition of 0.60 ha [1.47 ac] and 760 $m^3$ [1,000 cu yd] of excavation. The 0.35 ha [0.86 ac] of the land needed is presently owned by the State of Washington as part of the Retsil Veteran's Home. Representatives of the state indicate that property required for the reasonable expansion of the treatment facilities can be made available to the district.

Manchester. The existing site is located between Beach Drive and Puget Sound, approximately 0.62 km [1.0 mi] north of Manchester. The plant is some 9 m [30 ft] off the road and 90 m [300 ft] from Puget Sound. Sludge-drying beds are adjacent to the plant. An extensive screen of secondary-growth trees and shrubs forms a barrier to the east which shields views of the plant from Puget Sound. Scattered stands of trees lie to the north and south. No vegetation screens the plant to the west; thus the plant is extremely visible from the road. The plant lies in a marshy meadow with characteristic vegetation in unaltered areas.

Five to ten houses are along the slope flanking the western side of the site. The slope rises to a plateau generally running north-south. Few houses lie to the north. Twenty to thirty homes are located along the shore of Puget Sound within one kilometer of the plant and some 50 homes are in the town of Manchester to the south.

## Proposed Marine Disposal Sites

The outfall sites under consideration for future marine disposal of wastewater are the existing sites at Charleston, Port Orchard, Retsil and Manchester. Limited data are available on the benthic environment of the marine outfall sites. Some sampling was conducted at the Charleston and Manchester sites in conjunction with the Central Kitsap County Facility Plan (Reference 3). However, no extensive diving or sampling studies have been conducted in the vicinity of the outfalls. A summary of the probable marine fauna and known usages associated with the Sinclair Inlet and Manchester outfall sites is given in Table 19.

Charleston Site. The existing Charleston outfall discharges to Sinclair Inlet at a 10 m [32 ft] depth. Effluent is dispersed through twenty 16.5 cm [6.5 in.] diffuser parts at 6-foot intervals.

## Table 19. MAJOR MARINE FAUNA AND USAGES IN THE VICINITY OF PROPOSED WASTEWATER DISCHARGE SITES

| Marine environment summary | Sinclair Inlet outfall sites | Manchester outfall site |
|---|---|---|
| Mussels | x | x |
| Barnacles | x | - |
| Cockles | x | - |
| Manila clam | - | x |
| Bentnose clam | x | - |
| Butter clam | - | x |
| Geoduck (subtidal) | x | x |
| Littleneck clam (subtidal) | x | x |
| Mixed shellfish | x | x |
| Herring spawning areas | - | x |
| Surf smelt spawning areas | - | x |
| Major waterfowl areas | x | x |
| Eelgrass beds | x | - |
| General fishing area (sport salmon) | x | x |
| Concentrated fishing area (sport salmon) | x | x |
| Commercial salmon fishing (gill net) | x | - |
| Nonsalmon sports fishing | | |
| Cutthroat | x | - |
| Bottom fish | x | - |
| Commercial otter trawl | | |
| Regularly fished | - | - |
| Historically fished | x | - |
| Closed to trawl | - | x |
| Commercial herring fishing | x | - |
| College of Fisheries research areas | x | - |
| State tidelands | a | - |
| Aquatic land use allocations | | |
| Bedlands: aquaculture | - | x |
| commercial | x | - |
| Tidelands: Commercial | - | - |
| Marine terminals | x | x |
| Marine fuel stations | - | x |
| Shoreline zoned business/commercial | x | - |
| Presence of existing outfalls | x | x |

Source: Reference
Note: "a" indicates nearby.

The present outfall discharges east of the Puget Sound Naval Yard and experiences indirect effects of the Naval Yard cooling water and ship discharges. Programs are currently underway to complete an industrial wastewater treatment system and ship waste collection system at the Naval Yard by 1977 and 1979, respectively. These two systems will discharge to the Charleston treatment plant. However, cooling waters will continue to be discharged directly to Sinclair Inlet. This typically produces a slightly warmer surface and water column zone which is attractive to some shorebirds and fishes. Shellfish numbers are probably limited in this portion of Sinclair Inlet and shellfish harvesting is generally not allowed due to high levels of coliform bacteria indicating possible fecal contamination.

Port Orchard Site. The Port Orchard outfall follows the existing wharf and extends beyond the marina. The construction of the marina and filling of the shoreline has greatly altered the marine ecology of the shoreline. Wooden pilings and structures offer intertidal and subtidal substrate for the attachment of mussels, barnacles and various types of marine algae. The concentration of small boats may slightly decrease the local water quality through discharge of small quantities of wastewater, gasoline and oil.

Retsil Site. The outfall from the Retsil plant passes through a relatively wide sand-gravel-cobble beach area before discharging into Sinclair Inlet. Although the inlet is closed to commercial shellfish harvesting, some recreational clam digging was observed in the intertidal area below the Retsil treatment plant by the EIS survey team in April 1977. This probably represents a significant recreational and potential commercial resource and should be recognized in any plan that would improve or degrade local water quality. In addition, Annapolis Creek, which flows past the treatment plant and empties across the above-mentioned beach, has historically been noted for runs of steelhead trout. Degradation of water quality at the mouth of Annapolis Creek and in the nearshore waters may have an adverse effect on returning and down-migrating trout.

Manchester Site. Very little is known about the marine environment in the vicinity of the Manchester outfall. However, Orchard Point and the adjacent Clam Bay have been noted for their excellent water quality. The National Marine Fisheries Service conducts research at Manchester focusing on feed and growth of salmon stock, stock development and fish genetics (Reference 49). The Environmental Protection Agency also maintains a regional support lab to monitor water and sediment quality, and study oyster embryo responses (Reference 50). Because of the good water quality, Clam Bay is used as a control station for comparison with other pollution studies in the Port Orchard system and Puget Sound (Reference 51). In addition, juvenile salmon are reared for commercial sale in Clam Bay. The effluent discharge point for the planned oily waste treatment facility at the Manchester Naval Fuel Supply Depot will extend approximately 50 m [150 ft] from shore, directly on-line with the end of the fuel pier located southwest from Orchard Point.

## Project Costs-Sinclair Inlet Discharge Strategy

### Capital Costs

Project implementation, as presented by the facilities planner, will require physical construction during the period 1978-80. Alternatives 2-5 will require a 12-18 months construction period sometime during this time frame. Salvage values are projected in the year 2000. Detailed alternatives representative of the Sinclair Inlet discharge strategy were evaluated using "high order-of-magnitude" estimates based on Part 2 of the facilities plan. Approximate error is estimated by the facilities planner to be +40 percent to -20 percent. The design period allows for 20 years of operation from first phase completion. Therefore, the design year is the year 2000. A 6-1/8 percent discount factor was used by the facilities planner to arrive at present worth and capital recovery calculations, with costs presented in January 1977 dollars. All costs in this analysis include costs of construction of primary and secondary treatment facilities, and engineering, legal and administrative costs (Reference 1).

Total capital costs for construction as shown in Table 20, range from a low of $16,778,000 for Alternative 2, to high of $19,441,000 for Alternative 5. This analysis assumed 75 percent federal and 15 percent state participation in capital funding, excluding total land and easement costs which are not grant eligible. Capital costs for Alternatives 2, 3 and 4 are fairly close - within six percent of each other. Total corresponding costs to local participating jurisdictions, as shown in Table 21, range from a low of $1,846,000 for Alternative 2, to a high of $2,914,000 for Alternative 4.

The net present worth of all capital costs, annual operation and maintenance (O&M) costs, and salvage, discounted at 6-1/8 percent annually, range from a low of $24,438,000 (Alternative 2), to a high of $27,108,000 (Alternative 5). Net present worth for each alternative is presented in Table 20.

Two rankings of project costs, based on analyses in Tables 20 and 21, are presented below. The first method ranks according to net present worth of all capital costs, annual O&M costs, and salvage value. The second method ranks according to average annual equivalent cost to the local Kitsap County Jurisdictions. In general, present worth for Alternatives 2, 3 and 4 were within 10 percent of each other and considered the same rank. Average annual equivalent costs for Alternatives 2, 3 and 5 were within 10 percent of each other and considered the same rank.

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Table 20. TOTAL PROJECT COSTS - ALL ALTERNATIVES
($1000)

| Alternative | Capital cost | Land & Easement Cost | Annual O & M | Present[b] Worth of all Costs | Salvage Value of Facilities and Land[c] | Net Present Worth[d] | Ranking (Net Present Worth) |
|---|---|---|---|---|---|---|---|
| 2 | $16,778 | $ 187 | $682 | $24,889 | $451 | $24,438 | 1 |
| 3 | 17,742 | 163 | 628 | 25,513 | 784 | 24,729 | 1 |
| 4 | 17,769 | 1,263 | 756 | 26,353 | 0 | 26,353 | 1 |
| 5 | 19,441 | 186 | 691 | 27,918 | 810 | 27,108 | 2 |

[a] Operating and maintenance costs are calculated on the basis of certain fixed charges per year plus variable costs which are affected by increased flow. This method does not create a linear yearly increase. Therefore, O&M costs for the year 1990 were selected because it is the median year over the service life of the treatment facilities (1980-2000)

[b] The present worth (in January 1977 dollars) is the sum of 20 years of operation and maintenance costs discounted at 6-1/8 percent plus the total capital costs.

[c] Because the useful life of transmission lines - 50 years - exceeds the evaluation period of 20 years, a straight-line depreciation was used to determine the salvage value at the end of the evaluation period. The salvage value was 60 percent of the construction cost.

[d] Present worth of all costs less the present worth of the salvage value of the transmission lines.

Source: Reference 1.

### Table 21. KITSAP COUNTY JURISDICTION COSTS - ALL ALTERNATIVES[1]
($000)

| Alternative | Capital Cost[a] | Capital Recovery[b] | Annual O & M[c] | Average Annual Equivalent Cost[d] | Ranking (Average Annual Equivalent Cost) |
|---|---|---|---|---|---|
| 2 | $1,846 | $188 | $682 | $870 | 1 |
| 3 | 1,921 | 196 | 628 | 824 | 1 |
| 4 | 2,914 | 297 | 756 | 1,053 | 2 |
| 5 | 2,108 | 215 | 691 | 906 | 1 |

[a] Kitsap County Jurisdictions include: the County of Kitsap, the City of Bremerton, and the City of Port Orchard.

[b] Assumed federal participation of 75 percent and state participation of 15 percent on total capital costs less total land and easement costs which are not grant eligible.

[c] Annual payment required to recover local Kitsap County jurisdictions' share of the capital costs at 8 percent for 20 years.

[d] From Table 17.

[e] Represents O & M charges plus capital recovery costs to participating local jurisdictions.

| Alternative | Net Present Worth | Average Annual Equivalent Cost to Kitsap County Jurisdictions |
|---|---|---|
| 2 | 1 | 1 |
| 3 | 1 | 1 |
| 4 | 1 | 2 |
| 5 | 2 | 1 |

### Operation and Maintenance

Each project alternative represents a separate series of annual costs for the operation and maintenance of the treatment plants and transmission pump station. These costs are the sum of fixed annual charges and increasing variable charges relating to increased flow capacity. Since O&M costs increase over time, the facilities planner has chosen the specific O&M costs for 1990, the median year of the service life of the treatment facilities (1980-2000) as mathematically representative of annual costs. These annual costs range from a low of $628,000 (Alternative 3) to a high of $756,000 (Alternative 4). Costs for each alternative are presented in Table 20.

## Revised Alternative 2 Project Costs

In Volume II, Part 3 of the Sinclair Inlet Sewerage Facilities Plan, a preliminary design and detailed cost estimate was made for Alternative 2 only. These detailed estimates reflect increased costs due to the addition of new pump stations, sewers and service areas, pump station modifications, finalization of treatment processes, and other miscellaneous costs not identified in Part II - Development of Alternatives.

Capital costs and O&M costs for the treatment plants, pump stations and transmission lines were evaluated for the most cost effective systems. However, a net present worth, similar to that calculated in January 1977 dollars in Table 20, was not made. The facilities planner instead compared capital cost allocations in inflated 1980 dollars for each treatment facility according to the funding entities. For the purposes of comparison with Table 20, a net present worth was calculated based on capital cost and O&M present worth values as developed for each facility in Chapters 16 and 17 of Volume II of the facilities plan. The revised total project cost, as presented in Table 22, is approximately $31,800,000. This figure represents a $7,000,000 increase over the amount shown for Alternative 2 in Table 20. A percentage change cannot be estimated because the revised figure contains new items, some of which are specific to this alternative

## Table 22. REVISED PROJECT COSTS-ALTERNATIVE 2[a] (SEPTEMBER 1977)

| Cost Component | Value ($1000) |
|---|---|
| Capital Cost | 22,771 |
| Land and Easement cost[b] | - |
| Annual O & M[c] | 859 |
| Present worth of all costs[d] | 32,523 |
| Salvage value of facilities[e] and land | 674 |
| Net Present Worth[f] | 31,849 |

[a] Does not include present worth of any delayed construction wich may be required before year 2000, nor capital cost of Manchester collection system which was not given (and has separate funding).

[b] Assumed by facilities planner to be an insignificant cost item which amounts to less than 1 percent of capital cost.

[c] Treatment Plants: Average O&M costs for mid-design-year 1990; pump stations and transmission lines: O&M costs for 1980

[d] See Table 17, footnote b

[e] See Table 17, footnote c

[f] See Table 17, footnote d

Source: Reference 2.

only, and were not calculated in the first analysis. Therefore, equivalent increases in total project costs cannot be made for Alternatives 3 through 5. It is fairly certain, however, that if a similar detailed analysis were performed for the remaining alternatives, the resultant total project costs would be higher than those presented in Table 20.

## INTERACTION WITH OTHER PLANS

### Kitsap County Comprehensive Plan

Comprehensive planning for sewerage facilities was established with the 1970 "Comprehensive Water and Sewerage Plans for Kitsap County" (Reference 52) Projected sewerage service areas for 1975 and 1990 within the planning area are shown in Figure 20.

The county comprehensive plan indicated four wastewater treatment facilities by 1990. The present wastewater facilities plan for Sinclair Inlet incorporates the two Bremerton facilities into one at Charleston and the Port Orchard/Retsil facility will probably be at Retsil instead of on Blackjack Creek. Population projections and resultant flows are overall slightly lower than the comprehensive plan. Also, in contrast to the comprehensive plan, Sunnyslope, between Gorst and the county airport, and small portions below Port Orchard, above Tracyton and around Wildcat Lake will not be included in the 2000 sewer service areas of the facilities plan.

The comprehensive plan for the portion covering central Kitsap County was amended in May 1976 (Reference 53) to incorporate the Central Kitsap County Facilities Plan. Areas within the Sinclair Inlet planning area that are now excluded from the facilities plan are shown in Figure 20. These areas will not be serviced by the central Kitsap treatment facility.

### Central Kitsap County Wastewater Facilities Plan

The recently completed Central Kitsap County Wastewater Facilities Plan (Reference 3) examined a regional treatment facility for sub-basins 9 and 10 north of the Sinclair Inlet planning area which included Silverdale, Meadowdale, Brownsville, the Bangar Naval Reservation and the proposed Trident Support Site. Poulsbo and Keport to the north also have the option to join the central Kitsap regional system.

The Central Kitsap Facilities Plan selected a site for a regional plant approximately 3 km [2 mi] north of Burke Bay on Highway 303.

The plant will be able to provide urgently needed service to several recent housing developments which are all on interim sewage disposal systems. Some of these housing developments fall within the northernmost portion of the Sinclair Inlet planning area; however, they are planned to have their sewage pumped into the central Kitsap regional facility. These areas, which will in the future by served by the central Kitsap facility, are shown in Figure 20.

## Kitsap Basin Water Pollution Control and Abatement Plan

An area-wide program of pollution control for the waters of the Kitsap Basin (Reference 54) was conducted by the PACE Corporation in 1973 to conform to the Washington State Department of Ecology's "Sewage Drainage Basin and Urban Area Planning Guide for Water Pollution Control and Abatement" (September 1970) and the EPA's "Water Quality Management" guidelines (January 1971). This program reviewed all nonpoint pollution sources as well as point sources and in effect fulfilled section 208 of Public Law 92-500 on the Clean Water Program. The final report: Kitsap Basin Water Pollution Control and Abatement Plan (KBWPCAP) (Reference 54) was published in 1975 with five treatment alternatives for the Sinclair Inlet planning area. Three alternatives are incorporated into the Sinclair Inlet facilities Plan. A fourth alternative with a regional plant and discharge at Enetai was considered during the discharge strategy development. A fifth alternative with a regional plant at Bainbridge Island serving central Kitsap County and Sinclair Inlet was not considered in the Sinclair Inlet Facilities Plan.

## The Shoreline Management Act

In 1971, the State of Washington enacted the Shoreline Management Act (SMA), a comprehensive program to coordinate coastal development with protection of natural resources. The SMA designated two categories of management areas: 1) A "resource area", over which SMA has permit authority, composed of all sub-tidal and tidal lands up to 60 m [200 ft] beyond the mean high water line; and 2) a planning and administrative area composed of the fifteen coastal counties. SMA required all coastal counties to inventory their coastal resources and identify all relevant planning goals and policies. In response, Kitsap County developed a Shoreline Master Program and a shoreline inventory (Reference 55) in 1973. The following policies, relevant to the Sinclair Inlet Facilities Plan, were developed by the Shoreline Master Program and SMA planning activities for Kitsap County:

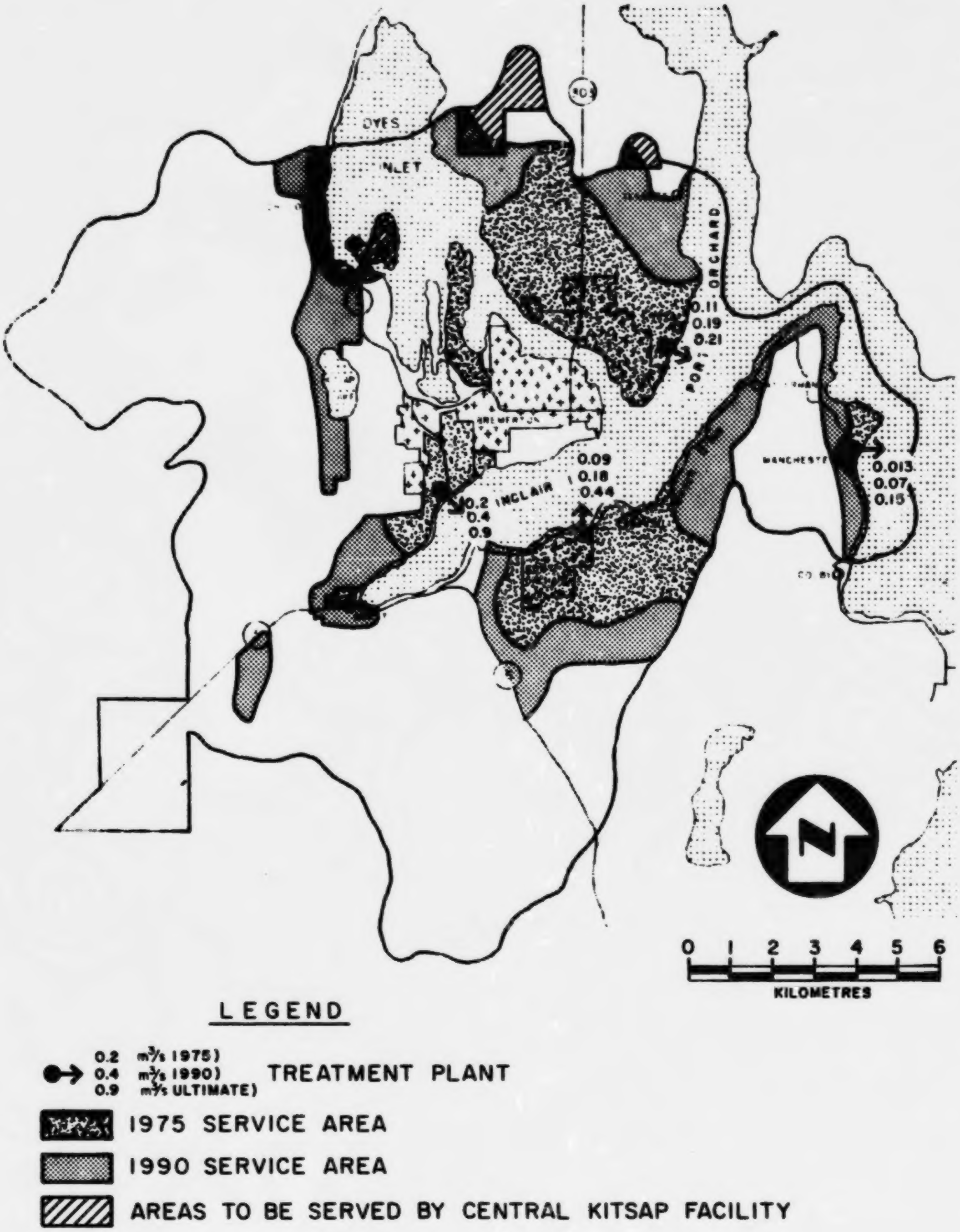
DYES
INLET
303
PORT ORCHARD
0.11
0.19
0.21
BREMERTON
0.09
0.18
0.44
0.2 SINCLAIR
0.4
0.9
MANCHESTER
0.013
0.07
0.15
16
0 1 2 3 4 5 6
KILOMETRES
LEGEND
0.2 m³/s 1975)
0.4 m³/s 1990)
0.9 m³/s ULTIMATE)
TREATMENT PLANT
1975 SERVICE AREA
1990 SERVICE AREA
AREAS TO BE SERVED BY CENTRAL KITSAP FACILITY

FIGURE 20 KITSAP COUNTY COMPREHENSIVE SEWERAGE PLAN

1) Preferences to shoreline uses should be given to the following categories in order of priority:

   - Water-dependent uses including intakes and outfalls as approved by existing legislation

   - Water-related uses

   - Nonwater-related uses including utility right-of-way and sewage treatment plants

2) Gorst Estuary - Water-dependent and water-related uses as defined above are prohibited from railroad trestle on north shore westward to Gorst and from Gorst eastward on the south shoreline to and including the urban area located at Section 33.

3) Other general policies that would affect facilities planning:

   - Restoration of shorelines after construction

   - Use minimal amount of shoreline in development and provide multiple use opportunities

   - Parking areas and facilities located inland and screened from shoreline

   - Floodplains, storm flooding areas, steep slopes, marshes, estuaries, and bogs should not be developed

   - Development encouraged to locate away from immediate shoreline

   - Vegetative buffer provided between normal high water mark and upland use.

4) Use activity policies:

   - Whenever utilities must be placed in a shoreline area, the location should be chosen so as not to obstruct or destroy scenic views. Whenever feasible, these facilities should be placed underground, located away from the water's edge and/or designed to do minimal damage to the aesthetic qualities of the shoreline area.

   - Utilities should be located to meet the needs of future populations in areas planned to accommodate this growth.

- Development that requires utility services should not be approved until such utility services are programmed for operation.

- Developments that require utility services should not be utilized until such utility services are in operation.

# SECTION IV

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# SECTION IV

# ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Each alternative wastewater treatment system will have both beneficial and adverse impacts upon the natural environment as well as on institutions, the economy and energy utilization rates. These impacts were assessed on the basis of available scientific knowledge, the professional experience of individual project team members, consultation with local experts in specific fields, and familiarity with local conditions gained by the project team during data collection and investigation of the study area.

The Environmental Protection Agency guidelines for the preparation of the Environmental Impact Statements (40 CFR, Part 6, § 6.304 (c)) require that primary and secondary environmental impacts for short and long-term duration, be evaluated. This draft EIS identifies the short-term, long-term direct and long-term indirect (secondary) impacts related to all project alternatives.

## SHORT-TERM IMPACTS

The direct short-term impacts of this project are related to construction activities. These impacts are relatively minor in effect and magnitude, and in most cases the adverse impact can be effectively mitigated, though not completely eliminated. The impacts are summarized and evaluated as to their positive, neutral or negative effects in Table 23. Mitigation measures, which are recommended for construction grant approval, are presented for each adverse impact. Supporting discussions for some individual impacts can be found in Appendix G.

## LONG-TERM DIRECT IMPACTS

### Soils and Geology

The alternative projects will have little direct impact either upon the soils or geological features of the study area. Geological hazards may cause pipe failures or other system problems. Potential effects of strong seismic tremors may be of importance, although the actual effects or probability of occurrence cannot be estimated. Pipeline connectors and pump stations would respond differently from the pipelines and the surrounding fill material during stress situations.

## Table 23. SHORT-TERM IMPACTS AND MITIGATION MEASURES

| Impacts | Alternative<br>1 | 2 | 3 | 4 | 5 | Recommended Mitigation Measures |
|---|---|---|---|---|---|---|
| 1) Soil erosion from construction disturbed sites | ⦶ | ◑ | ◑ | ◑ | ● | • Schedule construction to dry season<br>• Confine surface disturbances to immediate construction areas<br>• After construction, exposed soil areas should be reseeded with native grasses |
| 2) Dust generation | ⦶ | ◑ | ◑ | ◑ | ◑ | • Keep soil wetted down in construction area |
| 3) Aerial pollutants | ⦶ | ◑ | ◑ | ◑ | ◑ | • All vehicles and equipment should be fitted with properly maintained pollution control devices |
| 4) Stream channel disturbances during construction | ⦶ | ◑ | ◑ | ⦶ | ● | • Interceptor ditches around construction site to catch run-off<br>• Care should be taken not to discharge petroleum or other pollutants to stream<br>• Limit construction near streams to low-flow periods (late summer) |
| 5) Loss of groundcover/ disruption of wildlife habitats | ⦶ | ◑ | ◑ | ◑ | ◑ | • Replanting with native vegetation where possible<br>• Vegetation near pipelines should be flagged or fenced to minimize construction damage |
| 6) Disruption of wildlife patterns and aquatic fish migrations | ⦶ | ◑ | ● | ◑ | ● | • Vegetation removal in natural areas occur during late summer or fall when nesting birds are not present<br>• Avoid construction near streams during fish migration periods: Sept-Nov, March-May |
| 7) Increased noise and vibrations | ⦶ | ◑ | ◑ | ◑ | ◑ | • All equipment should have mufflers properly installed and maintained<br>• Limit activities to daylight hours |
| 8) Visual impact of construction equipment and site | ⦶ | ◑ | ◑ | ◑ | ◑ | • Equipment should be stored in designated areas, all litter picked up<br>• Fence or otherwise screen construction maintenance area |
| 9) Soil disposal from excavation | ○ | ○ | ○ | ○ | ○ | • Disposal of soil material should be coordinated with other ongoing projects requiring fill |
| 10) Stockpiling and storage of spoil | ○ | ○ | ○ | ○ | ○ | • Spoil material not needed for backfilling should be spread on ground and seeded or covered to prevent dust and erosion |
| 11) Safety hazard | ⦶ | ◑ | ◑ | ⦶ | ◑ | • All open trenches should be covered or fenced at end of work day<br>• All construction equipment should be secured against unauthorized use<br>• Construction area should be well marked and access restricted where possible |

### Table 23. SHORT-TERM IMPACTS AND MITIGATION MEASURES (Cont'd)

| Impacts | Alternatives 1 | 2 | 3 | 4 | 5 | Recommended Mitigation Measures |
|---|---|---|---|---|---|---|
| 12) Construction-related traffic | ⦶ | ◑ | ◑ | ◑ | ◑ | • Scheduling to avoid peak traffic periods in area |
| 13) Disruption of through and local traffic | ⦶ | ● | ● | ◑ | ● | • Barricades and flagmen posted as necessary to guide traffic through construction zones<br>• Notify local residents as to location, nature and duration of construction |
| 14) Utility service disruption | ⦶ | ◑ | ◑ | ⦶ | ◑ | • Advance notice of utility service disruption should be given<br>• If disruption occurs over a long period, utility bypasses should be provided |
| 15) Disturbance of marine benthic communities during pipeline construction | ⦶ | ● | ● | ⦶ | ● | • Locate pipeline/outfall to avoid significant shell fish and finfish areas<br>• Avoid identifiable critical spring and summer use periods |
| 16) Marine water quality | ⦶ | ◑ | ◑ | ⦶ | ◑ | • Care should be taken not to discharge petroleum or other pollutants to inlets |
| 17) Potential for disruption of archaeological/historical resources | ⦶ | ⦶ | ⦶ | ⦶ | ⦶ | • Upon discovery of remains, construction should be halted and State Historic Preservation Officer contacted to determine appropriate measures |
| 18) Employment, direct and indirect | ⦶ | ○ | ○ | ○ | ○ | • None necessary |
| 19) Economic activity, direct and indirect | ⦶ | ○ | ○ | ○ | ○ | • None necessary |

| Key: | |
|---|---|
| ○ | Beneficial impact |
| ⦶ | No change or minor adverse impact |
| ◑ | Moderate adverse impact |
| ● | Significant adverse impact |

Differential movement between the connectors and pumps and the pipelines may cause leakage and ruptures at these points during strong tremors.

Alternative 2

Consolidation of the Manette with the Charleston plant and the Port Orchard with the Retsil plant would require 8,400+ m [28,000+ ft] of pressurized pipeline. The Manette-Charleston pipeline would contain many joints and turns through the Bremerton area. The pressurization, long distances and sharp angle turns of this pipeline may increase the potential for leakage and rupture during a strong tremor (e.g., 7.0 Richter scale with a horizontal ground acceleration of 0.5g). Construction techniques such as installation of sand beds prior to laying pipe in the trench, backfilling with fine soil and thorough compaction should lessen adverse effects from tremors. The significance of such induced effects during the tremors should be judged against the greater effect upon surface structures, both of the alternative facilities and the urban area in general. Treatment facilities, as would be constructed at the Charleston and Retsil sites, have generally withstood tremors with little damage. Normal foundation requirements for the heavy structures of treatment facilities are sufficient to reduce or eliminate problems arising from ground instability during tremors. However, some additional consideration should focus on the presence of the Kitsap clay member of the Orting formation found under the Charleston plant site. Groundwater saturation of this clay would increase pore-pressure and allow movement during the shaking or lurching which would accompany a strong tremor. The highway and railroad embankments on the east side of the site may contain any movement, but the clay, it's overlying fill and structures may be affected by differential movement. Structures partially located on fill and on bedrock clay or other glacial deposits may respond to a tremor differentially and cause breakage of facilities passing across the boundary between the two foundation materials.

The Port Orchard-to-Retsil pipeline would have fewer sharp angle turns and would be only about 2,400 m [8,000 ft] long. As such, the pipeline would generally be less affected than the longer, more angular Manette-Charleston pipeline. The replacement of the existing treatment facilities at Port Orchard with a pump station would lessen possible damage to the alternative system. The location of the existing facilities over a deep fill, even with adequate foundations may permit differential movement of pipes entering the facilities and rupture could be anticipated at the connections during a strong tremor. Furthermore, failure of the surrounding fill may occur at a location adjacent to the inlet.

The corridor between the Port Orchard and Retsil sites would lie close to the underlying glacial bedrock. A subtidal pipeline route from Port Orchard to Retsil would cross large mudflats into zones of steep, subtidal slopes. Strong tremors may dislodge poorly compacted alluvium, and slumping and lurching could cause leaks and ruptures of the pressurized pipeline. The Beach Drive roadway along Sinclair Inlet would act to contain the fill for the Retsil plant site. The new Retsil plant would be smaller than the Charleston plant and, therefore, less subject to potentially damaging tremors. The expansion of the Manchester plant would occur on or near clay deposits of the Kitsap member of the Orting formation. Such materials with unconfined fill along a small creek may allow for groundwater saturation of both the fill and the clay. Such conditions may allow substantial differential movement and ground instability during a strong tremor.

## Alternative 3

This subregionalization alternative would involve about 11,890 m [39,000 ft] of new pipeline and the Charleston and Manchester plants. The 6,100 m [20,000 ft] of the Manette-Charleston pipeline and the 3,350 m [11,000 ft] of the Port Orchard-Charleston pipeline would increase the probability of pipeline rupture during strong tremors. The Manette-Charleston pipeline hazards have been discussed in Alternative 2, but the Retsil-Port Orchard-Charleston pipeline may be more hazardous than the Bremerton pipelines. From Port Orchard west along Highway 160, the pipeline would lie within clay deposits of the Kitsap member of the Orting formation. Because of the high water table and seepage along the adjacent bluff, these deposits may be saturated throughout most or all of the year. During a tremor, differential movement may dislocate the roadbed and the pipeline. Rupture or leakage of the pipeline may induce further movement of the Highway 160 roadbed. At the west end of the inlet, crossing the steeper subtidal slopes may pose a similar instability hazard for the pipeline and adjacent roadbed. The subtidal route between Ross Point and Retsil may be subject to greater seismic hazards than along the road. Seismically-induced lurching of the subtidal slope and roadbed could cause ruptures or leakage of the pressurized pipeline.

Effects on the Manchester plant expansion, the Retsil-Port Orchard pipeline, the Manette plant replacement and the Manette-Charleston pipeline would be the same as Alternative 2.

## Alternative 4

Expansion of existing local treatment plants would generally increase possible damage to pipes within the facilities but would reduce possible hazards of long pressurized pipelines. Expansion of the Manette plant would expose the facility to an increased potential for slope failure. The 9-15 m [30-50 ft] high slope descends directly to the water of the narrows and may be supported below water level by the clay deposits of the Kitsap member of the Orting formation. Constant water submergence may allow saturation of the clay which may prove unstable during strong tremors. Even with proper foundations for the treatment facilities, pipeline and outfall leakage and rupture could be anticipated during a tremor.

Various effects and responses of the Charleston, Port Orchard, Retsil and Manchester plants have been discussed in the preceding alternative discussions. Expansions of the present Port Orchard and Manchester plant may substantially increase the adverse effects of strong tremors on the plants and the resulting malfunctions and spillage.

## Alternative 5

Subregionalization in this alternative would require 16,900 m [55,500 ft] of pressurized pipeline and would generally increase the potential for adverse effects resulting from strong tremors. A potential for lurching and differential settlement or liquification may exist between the Port Orchard and Retsil plants and along Beach Drive. Along Sinclair Inlet, the Port Orchard-Manchester pipeline may lie on the inland side of the roadway and would be protected from wave erosion, but the large amount of fill, the softer clay deposits of the Kitsap member (Orting formation) and the steep subtidal slopes along the inlet would suggest that some potential exists for lurching or differential settlement during strong tremors along the pipeline route. A subtidal route would be subject to wave erosion. Softer alluvial sediment of Little Clam Bay and clay deposits of the Kitsap member underlie the pipeline route along Little Clam Bay north of the Manchester plant.

This alternative would contain more pipeline than Alternatives 2, 3 and 4, and may have longer subtidal routes than 2 and 3. The Manchester plant expansion would be greater than in other alternatives. Overall effects upon this alternative could be greater than those upon Alternative 2 but may be quite similar to, if not somewhat less than, the level of those on Alternatives 3 and 4.

## Mitigation Measures

Potential for system failures during the operation of project facilities and associated extension of collector sewers would be reduced by adequate soils investigations, especially for the Charleston and Manchester plants in Alternatives 2-5. Facilities should be designed to minimize ruptures along the shore roadways north of the Charleston, Port Orchard, Retsil and Manchester plants, where waterlogging could endanger the stability of the roadbed. Some analyses and planning should also focus on the stability of foundations and pipelines during tremors with a horizontal acceleration of 0.5 g.

## Air Quality

The present air quality in the study area is generally good to excellent throughout the year. Because none of the project alternatives will contribute significant emissions of photochemical smog components to the local air basin, there will be no adverse impact on the region's air quality. However, the potential for localized odor nuisances is present in the areas surrounding the various treatment facilities.

## Odors

Generally, properly operated sewage treatment facilities of the proposed designs do not produce nuisance odors, nor does the digested sludge. The normal condition in any well-operating treatment plant is the production of a musty or earthy smell. While this smell is not offensive to most people, there are some persons that are sensitive to it and may consider it to be a nuisance.

Nuisance odors resulting from treatment processes or plant operation imbalances sometimes occur because of drastic changes in sewage quality due to shockloading, high or low pH, toxic substances or high temperature. Also, odors may be noticed around a treatment plant when tank trucks deliver undigested septic tank sludge, or when a malfunction in the sewage collection system delays flows to the plant. At the Charleston, Retsil and Manchester sites where sludge-drying beds will be operating, odor generation may occur under warm weather conditions. The coincidental occurrence of air stagnation, or temperature inversion, during an odor-production episode can prevent the rapid dispersal and dilution of odors, thus worsening the degree of impact.

Table 24 summarizes the odor potentials for each of the alternatives and notes the land uses most likely to be affected.

### Mitigation Measures

One means of reducing the likelihood of odors resulting from sewage treatment, is to utilize air injection in all force mains con-

Table 24. LAND USES IN THE VICINITY OF TREATMENT PLANTS LIKELY TO BE AFFECTED BY POTENTIAL ODORS FROM EACH ALTERNATIVE

| Alternatives | Treatment Plant Sites | | | | |
|---|---|---|---|---|---|
| | Bremerton/Manette[a] | Bremerton/Charleston[b] | Port Orchard[c] | Retsil[d] | Manchester[e] |
| Alternative 2 | 0[f] | 0 | | | X |
| Alternative 3 | 0 | 0 | | | X |
| Alternative 4 | 0 | 0 | X | X | X |
| Alternative 5 | 0 | 0 | | | X |

[a] Will affect park users

[b] Will affect 15 to 20 residences

[c] Will affect commercial district

[d] Will affect Veterans' Home

[e] Will affect residences

[f] 0 = Anaerobic digestion proposed--Less potential for odor production

X = Aerobic digestion proposed--Greater potential for odor production

References: 3 and 56

Table 25. SITES EXPECTED TO EXPERIENCE SLUDGE TANK TRUCK TRAFFIC AND NOISE

| Alternatives | Treatment Plant Sites | | | | |
|---|---|---|---|---|---|
| | Bremerton/Manette | Bremerton/Charleston | Port Orchard | Retsil | Manchester |
| Alternative 2 | X | X | | X | X |
| Alternative 3 | X | X | | X | |
| Alternative 4 | X | X | X | X | X |
| Alternative 5 | X | X | | | X |

veying raw sewage to the treatment plant. This air injection should guarantee that sewage influent will not be in a septic condition and therefore will not release odors upon entering the treatment plant. Another means is the use of deodorizing mists during period of particularly bad odor formation or during malfunctions. This method would be particularly useful for controlling odors from anaerobic sludge digestors at the Port Orchard and Retsil plants (Alternative 4), and the Manchester plant (Alternatives 2, 3, 4 and 5), all of which utilize anaerobic digestors. Transfer stations for tank trucks delivering undigested septic tank sludge should be designed to minimize sludge contact with the air.

Hauling of liquid sludge to private operators, as discussed in Section III - Alternative Plans, would greatly reduce the need for drying beds and hence the odor potential.

## Noise

Sewage treatment facilities are relatively quiet, and the facilities under consideration should not significantly increase daytime ambient noise levels. However, some electric motor noise may be detected immediately outside all facility locations at night when the ambient noise level drops. Slight, intermittent noise episodes during the day will be attributable to truck traffic to and from the plants. Table 25 summarizes the facility sites that would experience truck noise under the four alternatives. The same land uses near the alternatives' facility sites will be affected as are shown in Table 24.

### Mitigation Measures

Landscaping techniques, including vegetation screens, berms and fences, should be used to conceal noise sources, if not actually to diminish the volume of their emissions. It is especially important that such techniques be used at the Charleston and Manchester plants under Alternatives 2 through 5, and at the Retsil plant under Alternative 4. These three plants are adjacent to residential and institutional land uses. In general, noise levels from treatment facilities should not be allowed to exceed existing conditions by more than: 3 dBA for residential properties; 5 dBA for commercial properties; or 10 dBA for open space, agricultural or industrial properties.

## Fresh Water Hydrology and Water Quality

### Surface Water Hydrology

Generally there will be no new, long-term direct impacts of any significance to the study area's surface hydrology. The increase in impervious surface area created during construction will produce relatively miniscule volumes of additional runoff. Further, the situations of the facility sites preclude basinwide, or substantial local runoff-induced channel alterations because each sites is in close proximity to the marine shoreline. The closeness to the shoreline limits the areas that can be affected by increased runoff to a very small portion of each impacted basin. Lastly, there will be no direct discharges into any streams from the facilities which could increase stream flows and thus induce channel alterations.

Although the projects do not pose any long-term problems for the study area's surface hydrology, storm flow events over the life of the projects could conceivably cause damage to sewer lines crossing streams, particularly from such processes as streambed scouring. Damage to sewer lines could result in the spillage of raw or partially-treated sewage into streams. There is only a slight to moderate chance of this type of impact occurring unless runoff volumes are increased significantly by urban conversion of undeveloped land. This probability of impacts is low due to the relatively mild precipitation and runoff rates experienced in the area.

Mitigation Measures. The slight amount of additional runoff likely to be generated at the facility sites will be handled by drainage improvements designed into the individual projects. Water quality impacts resulting from site specific runoff is a minor, avoidable impact.

Some new sewer lines are likely to cross creeks and streams, thus, they will be subject to the possibility of storm runoff damage. The facilities planner should take this impact and its water quality ramifications into consideration to design sewer line creek crossings with the strength necessary to provide an adequate safety margin. This is an avoidable impact.

## Groundwater Hydrology

The hydrologic balance of each sewered basin, and possibly some unsewered basins (see Section II-Groundwater), will continue to be adversely affected, as it is now, by the exportation of extracted groundwater to the Puget Sound marine system through treatment facility discharges. This includes the deep aquifers tapped by wells in the Bremerton/Port Orchard area.

High groundwater levels, common throughout much of the study area, would continue to cause infiltration problems to the existing sewer system, and potentially for new sewers and interceptors. With the hazards of rupture during seismic events, groundwater may be locally contaminated by leaking sewage.

Mitigation Measures. The land treatment and disposal concept, if carried out in the study area, could minimally limit the volume of water presently being exported from the area's groundwater basins to Sinclair Inlet. The land disposal site that is considered in the facilities plan is located outside of the study area, thus, its use could not reduce the volume of groundwater being exported out of the study area's groundwater basins. This strategy was considered infeasible by the facilities planner.

In order to reduce the potential for groundwater contamination from seismic events, the facilities would be designed to minimize catastrophic physical damage. Since a large portion of the interceptor system will be constructed in areas subject to high groundwater, it will be necessary for sewers to meet stringent leakage tests following construction to help ensure against groundwater infiltration.

## Surface Water Quality

A long-term effect of the expanded sewage collection and treatment capabilities of the proposed project will be the reduction of nutrients from malfunctioning septic systems which enter streams situated in urban/suburban developed drainage basins. This will be accomplished by increasing the number of sewer hookups in these areas and channeling sewage to treatment facilities. By the year 2000, almost 86 percent of the population is anticipated to be sewered. This action transfers the nutrient problem directly from the source, bypassing the area's streams, to the Port Orchard Bay System.

The episodes of excessive coliform levels which have occurred in the study area's major streams and lakes may be reduced, both in frequency of occurrence and severity. However, the magnitude of the beneficial effect of this or the preceding impact is dependent on many factors, not the least of which is the total number of present septic system users who will retire their systems and hook up to an available sewer line.

The possibility of wastewater from sewer line ruptures discharging sewage into streams was mentioned earlier in the section on Surface Water Hydrology.

Mitigation Measures. No mitigations are necessary for beneficial effects of expanded sewage collection and treatment capabilities. Mitigations for sewer line ruptures were discussed previously in Surface Water Hydrology.

## Groundwater Quality

The primary anticipated long-term impact on groundwater quality will be a reduction in the contamination of local groundwaters by nutrients and pathogens released by malfunctioning septic systems. As stated earlier, the magnitude of beneficial effect for this type of impact is heavily dependent on the total numbers of septic system users hooking up to an available sewer line.

Sludge-drying beds are proposed for the Charleston, Retsil and Manchester facilities. Specific design details for sludge-drying beds have not been made yet by the facilities planner. If the drying beds have impermeable, lined bottoms, there will be little or no threat to local groundwater quality. If the beds are unlined, degradation of local groundwater could result to some degree. The degree would be determined by such factors as the design of the beds, the physical properties of the underlying soils, microclimatic evaporation rates, the volume of supernatant in the sludge and the depth to groundwater.

The facilities planner recommended that all sludge be dried and disposed to a landfill. However, cost comparisons were also made for sludge hauling distances that would be competitive with sludge-drying and disposal. In the Facilities Plan: Volume II-Part 3, it was determined that hauling of liquid sludge to distances of within 32 km [20 mi] of the Charleston plant and 20 km [12 mi] of the Retsil or Manchester plants was cost competitive. This assumes that an acceptable agreement can be reached with one or more landowners to receive liquid sludge in a storage lagoon on their property. With this method, the sludge may be recycled to the land as a fertilizer and soil amendment.

A liquid sludge storage lagoon and indiscriminate application upon land surfaces may have a potential for groundwater contamination through leaching of nitrogen and heavy metals into the soil. A degree of impact cannot be estimated without site-specific and operational details.

Mitigation Measures. Infiltration of dissolved solids and trace pollutants into the groundwater table under the sludge-drying beds can be avoided with design techniques. An impervious liner in the drying beds will eliminate percolation and perimeter ditches around the beds would collect any surface run-off or overflow.

Adverse effects from storing and applying liquid sludge at a private site are more difficult to mitigate. An impervious liner in the storage lagoon would eliminate percolation. Health and groundwater quality hazards from sludge application would fall under the jurisdiction of the County Department of Public Health.

## Terrestrial Environment

Operation of treatments plants or pipelines will have minimal impacts upon vegetation or wildlife. Tolerant wildlife species will adapt to sounds and odors associated with treatment processes. More sensitive animals may avoid the developed and inhabited areas.

Areas that may require further consideration are the mouths of Blackjack Creek at Port Orchard and Annapolis Creek at Retsil. These creeks has been recorded for migratory trout and salmon runs. Construction activities typically will increase turbidity, elevate water temperatures and lead to streambed deterioration through sedimentation. This could have a potential effect if construction occurred prior to or during salmon an trout spawning periods in the fall. Fish losses would not be apparent for the first season or year. However, in the following years fish productivity from that age class may be reduced. Effluent discharge from the Retsil plant could also have a long-term effect upon migratory trout within Annapolis Creek. The effect of a marine outfall a short distance from the mouth of Annapolis Creek may have some effects upon down-migrating juvenile salmon entering Sinclair Inlet. Chlorine residual and ammonia concentrations may have an inhibitory or toxic effect upon the nearshore marine life.

### Mitigation Measures.

The water quality-related mitigations presented in the Short-Term Impacts and Mitigation Measures section would be moderately effective in minimizing the project's long-term effects on fish productivity. Revegetation in the unused and perimeter areas of the facilities sites would provide some habitat for tolerant wildlife species.

## Physical Marine Environment

### Waste Disposal and Water Quality

The effects of wastewater disposal upon the receiving environment are dependent upon the quality of the discharge, the dilution it receives in the receiving water and the nature of the receiving water. Appendix C explains the mechanism by which dilution is accomplished in the marine environment and clearly defines the difference between initial dilution and subsequent dispersion and flushing. It is the cumulative effect of each type of dilution process that determines the suitability of a site for treated wastewater disposal.

## Initial Dilution at the Proposed Site

Two approaches to the calculation of initial dilution are generally used. The first approach is based on a mathematical model of dilution produced when a buoyant plume rises in a stratified liquid, which is in itself based on tests conducted in laboratory tanks. The second approach is based on the continuity equation:

$$C_o = \frac{ubd}{Q}$$

where

$C_o$ is the initial dilution

u is the current speed across the diffuser, ft/sec

b is the diffuser length, ft

d is the effective mixing depth, ft

Q is the wastewater flow rate, cfs

Irrespective of diffuser port configuration and sizing, the maximum initial dilution can be calculated in this way on the basis of the amount of clean water available for wastewater dilution that is passing over the diffuser. In most situations the latter approach provides a more reliable indicator of a site's potential from the point of view of initial dilution.

Table 26 compares applicable water quality standards with effluent from a secondary treatment plant which has been subject to dilutions of 10:1 and 100:1. Although this is a crude comparison and does not take account of complex interactions between waste constituents and water quality, it does demonstrate that at any disposal site which experiences good initial dilution it is reasonable to expect that secondary treatment will be sufficient to meet the standards.

From Table 26 it appears that an initial dilution of 100:1 would insure compliance with bacteriological standards in the study area.

Table 26. WATER QUALITY STANDARDS AND ESTIMATED DILUTED WASTE CONCENTRATIONS

| | Estimated waste concentration | | | |
|---|---|---|---|---|
| | A | Secondary effluent [a] | | |
| Characteristic | standard | Undiluted | Diluted 10:1 | Diluted 100:1 |
| Total coliform, MPN/100 ml | 70 | 1,000 | 144 | 68 |
| Dissolved oxygen, mg/l | 6 | 3 | 8.7 | 9.2 |
| pH | 7 - 8.5 | 6 - 9 | 7.9 - 8.2 | 7.9 |
| Toxicity, t.u. [b] | | 1.25 | 0.12 | 0.01 |
| Ammonium [c], mg/l | | 20 - 25 | 2 - 2.5 | 0.2 - 0.25 |
| Chlorine, mg/l | | 0.1 - 0.5 | 0.01 - 0.05 | 0 - 0.005 |

[a] Assumed background for secondary effluent is 59 MPN/100 ml for total coliform; 9.3 mg/l for dissolved oxygen; 7.9 pH value. (Reference 57).

[b] Assumes dechlorination of effluent.

[c] Can be significantly reduced by extending biological treatment period.

Based upon information relating to the distribution of current speeds from the University of Washington studies (Reference 20), the following Table 27 was prepared. This table compares the percent frequency the desired dilution ratio occurs at the sites. Port Orchard Bay at Enetai has been added for comparison purposes.

Table 27. PERCENT OF TIME SITE PROVIDES 100:1 OR MORE INITIAL DILUTION[a]

| | Frequency | | |
|---|---|---|---|
| Discharge site | Spring | Neap | Average |
| Manchester | 81 | 87 | 84 |
| Port Orchard at Enetai | 53 | 75 | 64 |
| Sinclair Inlet | 28 | 22 | 25 |

[a] Calculated using $C_0 = \frac{ubd}{Q}$ with b = 25 ft/MGD; d = 50 ft for Manchester; d = 30 ft for Port Orchard at Enetai; and d = 20 ft for Sinclair Inlet.

## Dilution Due to Circulation and Flushing

Inadequate dilution and dispersal of wastewater effluent can lead to long-term degradation of water quality and cumulative effects upon the marine environment. In this section, the dilution and dispersal potential for wastewater at each site is discussed. Port Orchard Bay at Enetai has been added for comparison purposes.

Puget Sound off Manchester. The outfall location was selected to take advantage of the southerly flow toward Colvos Passage during flood and the effect of Blake Island to the southeast. By locating the outfall at a depth of 42-45 m [140-150 ft], the shoal area east and southeast of Manchester tends to direct the flow from the outfall away from the Rich Passage flood inflow. Current speeds appear to be relatively weak, commonly near 0.1 to 0.2 knot with constant flow. During ebb-tide, a slow northerly flow can carry the dispersing plume in front of the ebb discharge from Rich Passage with resulting effective mixing (Reference 20). Due to its hydrodynamic characteristics and topographic position in the Puget Sound system, where eventually all the discharged effluents will end, the Manchester site offers very good flushing and circulation.

Sinclair Inlet. Due to the shallowness of the inlet and its feature as a closed-end appendage to the Port Orchard System, this area experiences weak tidal currents. The movement is bi-directional with a slow outward transport. The hydrological simulation of this area on a physical model such as in the University of Washington model, has several limitations. The shallow depth of the inlet, the large amount of shoreline and low tidal currents that are subject to wind-driven currents affect the accuracy of the model. Model results, in turn, are limited by surface tension and hydraulic factors associated with the scale of the model.

In addition to the model results, information is available from a dye study of the Charleston treatment plant outfall made on 23 and 24 January 1973 (Reference 58). Results indicated poor dispersal, with concentrations of effluent near the diffuser. Dilution ratios for surface samples ranged from 1.3:1 up to 2,140:1, depending on sample location, with an overall average of 250:1. Subsurface samples indicated considerably less dilution, with an average of 5.5:1.

Additional information was gathered through a drogue study on 29 July 1975 (Reference 1). Three drogues were released near the outfall site to follow current movements at three different depths simultaneously. The drogues basically remained in the area of release with drogues of different depths spreading in different directions. The scattering of the drogues demonstrated different water movement at three depths giving an indication of water stratification in the area studies. An average speed of 0.08 knot was calculated using all the drogue data.

Evidence of stratification can also be seen in the temperature profiles made by the University of Washington study (Reference 20). During late summer, surface waters within Sinclair Inlet reach up to 17°C. Temperature decreases gradually with depth and may be as much as 4° lower on the bottom. Stratification limits considerably the amount of water available for mixing and reduces the potential for assimilating waste discharges.

Calculation of the Sinclair Inlet dilution volume and exchange rate is complex and would require detailed computations and extensive field investigations. While quantitative data are limited on the hydrodynamics of Sinclair Inlet, rough calculations can be made based on comparisons with other extensively studied systems such as the San Francisco Bay system. At the mouth of San Francisco Bay (the Golden Gate), approximately 25 percent of the tide water is exchanged with each tidal cycle, i.e., 25 percent of the water returning with the tide, is new water. The exchange rate decreases with distance from the mouth towards the extreme end of the bay. Tidal inflow in the lower Port Orchard Bay/Sinclair Inlet system is mainly through Rich Passage. If it were assumed that the tidal exchange at Rich Passage near Point White (southwest tip of Bainbridge Island) was 25 percent, then a schematic diagram of the exchange rate in Sinclair Inlet/lower Port Orchard Bay could be made as shown in Figure 21.

The percentage of tidal exchange in the system decreases greatly west of Port Washington Narrows as shown in Figure 21. In the vicinity of the Charleston treatment plant outfall, tidal exchange is only 2.5 percent. With two daily tidal cycles, this means that near Charleston, 5 percent of the tidal water is exchanged each day. The change in water level between high and low tides is approximately 2.4 m [8 ft]. If an average depth of 12 m [40 ft] were assumed in Sinclair Inlet, then the tidal prism (water volume difference between tides) would be about one-fifth of the inlet volume. Thus total tidal exchange volume in Sinclair Inlet is one percent. The facilities planner has estimated the inlet volume to be 1600 times the effluent discharge flow. Thus the dilution of effluent to the volume of the inlet would reach 1:16 as wastewater discharges accumulate and attain an equilibrium level with Sinclair Inlet hydrography.

In actuality, the tide exchange rate at lower Port Orchard Bay is probably less than 25 percent, which would slightly increase the final ratio of wastewater to Sinclair Inlet volume. However, this represents a reasonable estimate that cannot be refined without further field work such as dye studies and current metering.

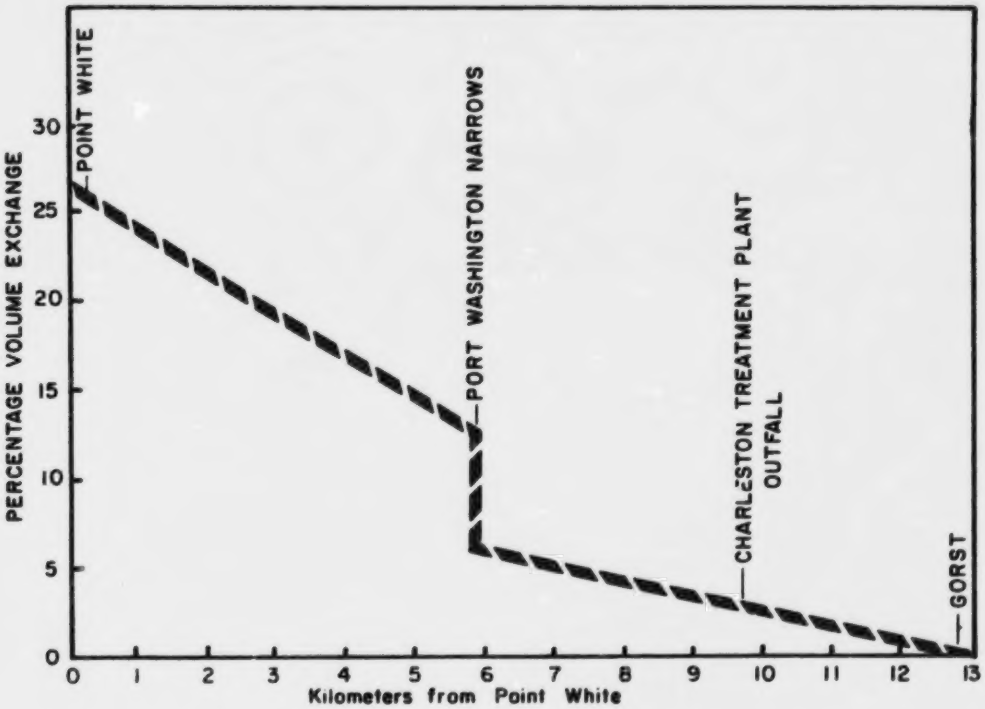

FIGURE 21 TIDAL EXCHANGE IN SINCLAIR INLET / LOWER PORT ORCHARD BAY

Due to the foregoing assessments and the fact that Sinclair Inlet is one of the farthest points from the Port Orchard circulation and exit to Puget Sound, the potential of this area for waste disposal is considered only fair.

Port Orchard at Enetai. Tidal currents at this site are strongly influenced by flood flows surging through Rich Passage and Port Washington Narrows. To a lesser degree, tidal movements in Sinclair Inlet have an effect upon the site at Port Orchard. Initially currents are southerly toward Sinclair Inlet. When the flood flow from Rich Passage reaches the site, there is a quick shift towards the north followed by energetic mixing both vertically and horizontally. During the ebb period, the area is quiet as it is bypassed by the flow from Sinclair Inlet. An outfall at this site should extend toward the middle of the Port Orchard Channel to take advantage of the additional flushing.

Currents are light during the ebbtide and the initial stage of the flood tide, but increase rapidly to 0.7 to 0.8 knots when the flood from Rich Passage reaches the site.

It is possible that some part of the dispersion plume can reach into Port Washington Narrows. It is fairly well accepted, however, that much of the diluted effluent would effectively exit through Rich Passage during the ebbtide. Due to its closeness to the exit from the system and to its hydrodynamic characteristics, this site is potentially good for waste disposal through a marine outfall.

### Mitigation Measures--

It is expected that with typical municipal wastewaters and normal, uneventful operation of the proposed wastewater treatment facility, the impacts upon marine water quality from treated effluent discharge to an appropriate site would be minimal. Proper facility design will result in appropriate pollutant reductions and minimize the potential for mishaps, and operation of the facility by properly trained personnel will further safeguard the environment. Mitigation to lessen the adverse effects of wastewater outfalls are centered around the outfall design. A single port diffuser, as is found on the majority of the outfalls in the planning area discharges effluent in a single stream. Effluent with low initial dilution could have a shock impact on marine organisms near the diffuser. A well-designed multiple-port diffuser would greatly mitigate this effect allowing wastewater effluent to be diluted greatly.

Optimum outfall diffuser design, as discussed above, would greatly reduce initial effluent pollutant concentrations and lessen the impacts on water quality and marine organisms. Uncertainty as to the ability of Sinclair Inlet to accept wastewater discharges over the long-term indicates the need for further examination. Mitigation of long-term effects upon Sinclair Inlet should consider further comparative investigations with other sites - particularly Enetai - before a final decision is reached.

## Biological Marine Environment

Effluent discharge from outfalls will be a continuous process during the life of the treatment facilities. Continued discharge of primary-treated effluent under Alternative 1 will perpetuate the present bacterial contamination problems which cause Sinclair Inlet to be closed to shellfish harvesting. Effluent quality will be upgraded in Alternatives 2-5. Impacts discussed below apply only to the current upgrading.

### Effects Upon Marine Biota

Effluent discharges will affect marine benthic fauna and flora. The effects of the effluent on the benthic community should be limited in area. Due to physical characteristics of the effluent such as salinity and density, the outfall plumes rise at a rapid rate from the outfall ports. A very limited bottom (benthic) area is exposed to effluent, resulting in restricted, site-specific, benthic impacts at each outfall location. The discharge will most likely limit the settling and colonization by new organisms rather than affecting existing outfall site inhabitants.

A review of the toxicity of trace constituents found in treated wastewater is shown in Table 28. Heavy metals can strongly affect some benthic organisms; specifically, copper and lead are toxic to oysters and total phosphorus affects the polychaete worm, *nereis grubei*. Oysters are generally not present at the 24 m [80 ft] depth at which the effluent will be discharged at Manchester but are present in Clam Bay immediately north of Manchester. Oysters are not found in great numbers in Sinclair Inlet, although they are harvested in Dyes Inlet.

The concentrations of copper and lead in the full-strength effluent are below the toxic level shown in Table 28. Design of the outfall to achieve high initial dilution will greatly minimize the concentration. The phosphorus concentration in undiluted effluent exceeds the toxic level for *N. grubei*, but the presence of this benthic community indicator species has not been established at the outfall sites. Toxic effects upon other benthic polychaete species are reduced because the wastewater plume would not directly contact the bottom habitat.

The effluent, as it rises to the surface, will change the water quality in the mixing zone. Fish in the mixing zone which contact the effluent directly above the diffuser could encounter nearly undiluted concentrations, while fish swimming closer to the surface will be exposed to a greatly diluted effluent.

As shown in Table 28, domestic effluent constituents in undiluted concentrations that are known to be toxic to fish are aluminum, ammonia and chlorine. Ammonia is the greatest concern in the initial dilution zone as effluent concentrations of 27 mg/l greatly exceed the maximum level to fish of 1 mg/l. Initial concentrations of ammonia near the outfall may present a shock hazard to aquatic life. Outfall design maximizing diffusion and dilution would reduce the potential shock effect. Chlorine residual is another parameter of concern where effluent concentrations of 1.0 mg/l exceed the 0.1 mg/l toxicity level to coho salmon. Chlorine dissipates rapidly in the marine environment, but nevertheless is of concern due to potential toxic effects at lower levels to juvenile fish and marine algae. The practice of heavy chlorination of effluent for disinfection causes chlorine residual to be of greater concern than heavy metals in the initial mixing zone.

The nutrients, nitrogen and phosphorus in various forms that will be present in the effluent will stimulate phytoplankton growth. Increased primary productivity through phytoplankton numbers widen the base of the food chain and can result in more herbivorous and carnivorous animals supported by the food web. Overstimulation can cause

## Table 28. TOXIC LEVELS OF CONSTITUENTS ON MARINE LIFE

| Constituent | Full strength concentration | Concentration in ambient sea water | Toxic level | Organism | Suggested maximum level |
|---|---|---|---|---|---|
| Ammonia | 1.35 mg/l | - | 1.0 mg/l [59] | Fish[a] | 0.1 mg/l [60] |
| | | | 3.4 mg/l [61] | Bluegill Sunfish | 0.3 mg/l [60] |
| Phosphorous (total) | 10.0 mg/l | 0.07 mg/l | 0.92 mg/l [62] | *Nereis grubei* | - |
| Mercury | 0.001 mg/l | 0.00003 mg/l | 0.9 mg/l [59] | Phytoplankton[a] | 0.009 mg/l [59] |
| Zinc | 0.12 ppm | 0.01 mg/l | 1.9 mg/l [59] | Steelhead | 0.019 mg/l [59] |
| Calcium | 30.5 mg/l | 400 mg/l | 800 mg/l [63, 64] | Stickleback | - |
| Iron | 1.3 ppm | 0.01 mg/l | - | - | 0.3 mg/l [59] |
| Copper | 0.025 mg/l | 0.003 mg/l | 1.9 mg/l [65] | Oysters[b] | 0.05 mg/l [66] |
| Chlorine | 1.0 mg/l | | 0.1 mg/l [67] | Coho Salmon[b] | 0.01 mg/l |
| Magnesium | 15.5 mg/l | 1.4 mg/l | 300 mg/l | Stickleback | 30.0 mg/l [59] |
| Aluminum | 0.31 ppm | 0.01 mg/l | 0.3 mg/l [60] | Stickleback | 1.5 mg/l [60] |
| Lead | 0.02 ppm | 0.00003 mg/l | 0.5 mg/l [59] | Eastern Oyster | 0.02 mg/l [53] |
| Manganese | 0.22 ppm | 0.002 mg/l | 0.4 mg/l [68] | Coho Salmon[c] | 1.0 mg/l [66] |
| Cadmium | 0.003 ppm | 0.00011 mg/l | 0.01 mg/l [66] | Fish[b] | 0.0003 mg/l [59] |
| Chromium | 0.043 ppm | 0.00005 mg/l | 17.8 mg/l [69] | Coho Salmon[a] | 0.05 mg/l [66] |
| Cyanide | 0.5 ppm | - | 0.05-0.1 mg/l [70] | Fish[b] | 0.025 mg/l [63] |
| Nickel | 0.016 ppm | 0.002 mg/l | 0.8 mg/l [63] | Sticklebacks | 0.1 mg/l [59] |
| Silver | 0.006 ppm | 0.0003 mg/l | 0.003 mg/l [63] | Sticklebacks | 0.005 mg/l [60] |
| Arsenic | 0.01 ppm | 0.003 mg/l | 5.3 mg/l [71] | Salmon | 0.5 mg/l [60] |
| Fluorides | 0.2 mg/l | 1.3 mg/l | 2.3-7.3 mg/l [72] | Trout[b] | 1.5 mg/l [66] |

[a] Various Limitations.

[b] TLM (96 hr) Median Tolerance Limit: 50 percent survival of test organisms in 96 hours.

[c] TLM (24 hours).

a gross imbalance in this primary productivity level. Subsequent die-off and decay of excess phytoplankton cells can consume large amounts of dissolved oxygen leaving critically low levels for fish and invertebrates. The hydrography of the outfall location will play a significant part in determining whether the nutrients from the outfalls have a potential to initiate or contribute to the intensity of a phytoplankton bloom.

Computer modeling of algal concentrations, as measured by chlorophyll a levels, was conducted by the facilities planner with the aid of the EPA Ecologic Model. The general model runs are discussed in Appendix E of the Sinclair Inlet Facilities Plan. The model indicates that secondary effluent outfalls at Sinclair Inlet and Port Orchard would demonstrate two stages. In the first stage, as the newly upgraded effluent is discharged, nutrient levels would be lower and algal blooms would be less intense. In the second stage, as the Port Orchard system equilibrates and greater volumes of effluent are discharged, algal blooms would recur with similar or greater intensity as before the upgrading of the effluent quality. This tends to show a widespread nutrient problem in the Port Orchard system from multiple sources aside from treatment plant effluents at Sinclair Inlet. The Ecologic Model was not simulated for a regional Manchester discharge or the absence of discharges with a land application strategy. Modelling under these conditions would have simulated Sinclair Inlet conditions with no wastewater discharges. Data from these model conditions could confirm or discredit pollutant effects from outside the system or to nonpoint sources.

It should further be pointed out that the Ecologic Model of Puget Sound was set up to simulate nutrient and algal concentrations for this study. No calibration or simulation was made for potential toxic constituents such as heavy metals or pesticides. After effluent has been diluted to an equilibrium level in Sinclair Inlet, accumulation of the trace toxic constituents, as discussed from Table 28, becomes of important concern.

## Mitigation Measures

Design of the wastewater outfall, particularly the diffuser system, would lessen adverse effects in the initial effluent mixing zone. Placement of outfalls in localities with optimal water movement would aid in the dispersion of toxic constituents. With the Manchester outfall, no further changes from present conditions are needed.

For outfalls into Sinclair Inlet (Charleston and Retsil) further consideration prior to finalization of outfall locations may be desired. Facilities plan improvements to the system are intended basically to meet Washington Class A Standards. Quantitative limits are set for coliform bacteria and several physical-chemical water quality parameters. Toxic constituent levels are recommended to the level necessary to meet public health standards. However, no quantitative standards have been set to protect marine organisms. As information on present and projected toxic constituents is limited, development of a more comprehensive information base is recommended. Calibration of this information into the Ecologic Model and computation of projected levels would aid in the determination of long-term maintenance and enhancement of marine productivity.

## Archaeological, Historical and Cultural Resources

General operational impacts of the alternative projects would have little direct long-term impact upon the resources of the study area, but some secondary effects within the sanitary collection system may in turn adversely affect archaeological, historical and other cultural resources. The increased treatment capacity of the plants in Alternatives 2-5 would allow the construction of new sanitary sewer lines. Excavations in the existing urban areas of Bremerton and Port Orchard may encounter some historic remains, while along the shorelines and along creek valleys a potential for encountering subsurface archaeological remains would be moderate to high.

### Mitigation Measures

Extensions in the present service area may adversely affect significant archaeological resources. These effects cannot be mitigated through this project and would largely fall under the jurisdictions of local authorities at the time of sewer line extension.

## Socio-Cultural and Economic Effects

### Long-Term Employment

Operation and maintenance of the Manette and Charleston plants currently require 13 persons. Port Orchard requires a half-time worker and Retsil, one person. Below are the additional manpower requirements projected for each alternative (Reference 1).

| Alternative | Additional Jobs Required |
|---|---|
| 1 | 0 |
| 2 | 15.5 |
| 3 | 13 |
| 4 | 19.5 |
| 5 | 15 |

Considering the unemployment situation in Kitsap County, the addition of these jobs can be considered a beneficial impact. No mitigation measures are required.

### Long-Term Business Activity

Operation and maintenance costs for the completed project will generate little or no new income for the Kitsap County economy. As a consequence, net change in overall business activity as a direct result of the project is expected to be negligible. No mitigation measures are required.

### Land and Property Values

It is not anticipated that implementation of the proposed project will have a significant, long-term effect on surround land values. Construction will occur in an economic environment of rising property values. With the provision of adequate sewerage to the study area, numerous malfunctioning septic tanks will be eliminated. These improvements will tend to further increase property values in the service area because adequate sewerage is limited elsewhere in the study area. These generalized effects will occur with Alternatives 2-5. No sewer improvements in Alternative 1 (no-action) would lead to a lower rate of appreciation, maintenance or lowering of property values in areas with septic problems.

If architecture and landscaping compatible with the area are incorporated into project designs, undesirability associated with the plants will be reduced. All major plant construction will occur at sites where treatment plants have existed for many years. Any potential reduction in surrounding land values associated with sewer treatment has alread been absorbed by the neighborhoods. Although expanded facilities will generate sludge at a faster rate, it is anticipated that collection and disposal will become more efficient. Thus, long-term impacts can be generally positive, if the existing facilities' aesthetic problems are adequately redressed during the implementation of the project. Specific effects on property value for alternatives requiring significant changes in land use are presented below:

Alternatives 2, 3 and 5. Expansion of the Charleston facility requires the removal of six homes. Construction of new buildings, tanks and sludge drying beds may affect the value of the 15 close neighbors. In general, the treatment facility is partly shielded from sites in a trough and no homes will be immediately adjacent to the facilities due to the steep hills to the east and west. The presence of the plant probably will not cause property value to decrease, although their value may increase at a slower rate than other areas in Bremerton. No significant property value effects will occur at the Retsil or Manchester sites.

Alternative 4. Similar impacts for the Charleston, Retsil and Manchester sites, as mentioned in Alternatives 2, 3 and 5, would occur. At the Manette site, up to 25 homes would be removed presenting a significant impact on land values. The presence of a moderately large treatment facility in the midst of a residential neighborhood would also negatively affect property values. Expansion at the Port Orchard site would require the conversion of shorefront commercial footage. Decrease in commercial land may cause the remaining commercial area to increase slightly in value. However, potential land use would be limited to that compatible with a treatment facility.

Mitigation Measures. The adverse effects on property values will be mitigated in large part by the changes described in the section dealing with Aesthetic Impact.

## Property Tax Revenues

Property tax impacts are expected to be minimal. Land purchased for expansion at the various locations will be tax exempt, thereby reducing revenue collections. However, some parcels currently being considered are already exempt. It is misleading therefore to assume that tax effects will parallel the land costs presented in the facilities plan.

The KCSD No. 5 (Retsil/Annapolis) facility is located on federal property. The land surrounding the Port Orchard plant is not generating tax revenue. Some of the land at Charleston is presently owned by the Humane Society and by the State of Washington.

Table 29 presents the potential loss in assessed valuation at Charleston, Manchester and Manette for each alternative. Corresponding reductions in tax revenue are estimated using 1977 tax rates for each location. The amounts are so small that no single jurisdiction will lose a noticeable amount. However, comparison between the alternatives indicates that Alternative 4 will result in a much greater impact.

No mitigation measures are applicable.

## Loans, Bonds and Subsidies

Ninety percent of project capital costs, other than land costs will be borne by state and federal grants. The federal government will assume 75 percent of grant eligible costs and the state will bear 15 percent. The Washington State Department of Ecology, acting as the state's 201 grant review agency, requires compliance with both state and federal requirements before certifying a project's eligibility.

## Table 29. PROPERTY TAX EFFECTS

| | Alternative | | | |
|---|---|---|---|---|
| Facility | 2 | 3 | 4 | 5 |
| **Charleston** | | | | |
| Assessed Valuation Reduction | $26,400[a] | $42,100[a] | 0 | $26,400[a] |
| Tax Rate[b] | $16.3893 | $16.3893 | | $16.3893 |
| Loss of Revenue | $ 433 | $ 690 | | $ 433 |
| **Manchester** | | | | |
| Assessed Valuation Reduction | 0 | 0 | 0 | $31,000[c] |
| Tax Rate[b] | | | | $16.232 |
| Loss of Revenue | | | | $ 503 |
| **Manette** | | | | |
| Assessed Valuation | 0 | 0 | $1,036,000[c] | |
| Tax Rate[b] | | | $ 15.7023 | |
| Loss of Revenue | | | 16,270 | |
| Total Loss of Revenue to All Jurisdictions | $ 433 | $ 690 | $ 16,270 | $ 936 |

[a] Actual Assessed Valuation of parcels under consideration.

[b] $/$1000 of Assessed Valuation

[c] Estimate per $CH_2M$ Hill based on average of assessed valuation of nearby land. Actual parcels have not been selected.

Sources: References 34, 36 and 73.

The capital costs of the Charleston treatment plant and transmission facilities will be partially funded by the U.S. Navy to cover the needs of the Puget Sound Naval Shipyard (PSNS). Granting agencies will not provide funds to cover the capital obligations of the PSNS. Consequently, the cost sharing for the Bremerton facilities must include the U.S. Navy as a major contributor.

The facilities planner estimated for Alternative 2, that the U.S. Navy share was approximately $1,100,000 in inflated 1980 dollars. Based on a rough estimate that 1980 costs are about 20 percent higher than 1977 costs, the Navy share would be approximately $900,000 in January 1977 dollars. The final cost to be shared by the Navy will be the result of direct negotiations among the EPA, City of Bremerton and the Navy.

Kitsap County and the cities of Bremerton and Port Orchard will issue revenue bonds to finance the local share of costs. Repayment of the debt will be guaranteed from the collection of user charges, which will be adjusted to meet debt service, and bond covenants. If these bonds were issued in the current market, it is estimated that they would bear tax-free interest at 7 percent. Retirement of the bonds would begin two to three years after issuance and continue until all had been paid off in 25 years. Collection would be adjusted to allow for creation of a reserve account to include coverage of one year of debt service. If covenants are similar to those of current issues, annual coverage of debt by 140 percent would be required. There is no limitation on the amount of revenue bonds that may be issued (References 74 and 75).

## Municipal Service Costs

It is not anticipated that operation of any of the alternative plans will create measurable impacts on any municipal services. Ongoing costs to finance and operate the new facilities will be paid by sewer customers through hook-up and user charges. No estimates for one-time connections have been made (Reference 36). Table 30 presents current service rates and estimated increases associated with each alternative.

## Utility Services

Natural Gas. Currently, only the Manette, Charleston and Retsil plants use natural gas for space heating. Total consumption at the three plants in 1976 was approximately 19,600 $m^3$ [700,000 cu ft], as shown in Table 31. The Manchester area has no natural gas service. The treatment facility there uses fuel soil supplied by private companies, as does the Port Orchard treatment plant. In all five facili-

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### Table 30. CURRENT SEWAGE SERVICE RATES AND PROJECTED INCREASES ASSOCIATED WITH THE PROJECT

| | Current Monthly Household | Approximate Monthly Household Rate Increase[a] | | | |
|---|---|---|---|---|---|
| | | Alternative | | | |
| Entity | Fee | 2 | 3 | 4 | 5 |
| Bremerton | $5.25[b] | $1.50 | $1.50 | $1.90 | $1.50 |
| Port Orchard | 5.50 | 2.40[d] | 2.00[c] | 3.10[d] | 3.00[d] |
| KCSD #3 (Manchester) | 5.50 | 3.00 | 3.00 | 3.00 | 2.10 |
| KCSD #5 (Retsil/Annapolis) | 5.25 | 2.40 | 2.00 | 2.50 | 3.00 |

[a] Rates are quoted as of May 1976, but were confirmed by telephone, April 1977. Rates do not include cost of rehabilitating local collection systems.

[b] $2.25 for houses built prior to 1968.

[c] Rate established assuming that Port Orchard and KCSD #5 are one entity for the purpose of computing rates. If rates are established separately, the estimated increase is $2.10 per household.

[d] Assumes Port Orchard and KCSD #5 are one entity for the purpose of computing rates.

Table 31. TOTAL AND PEAK-MONTH GAS CONSUMPTION
MANETTE, CHARLESTON AND RETSIL TREATMENT PLANTS, 1976

| FACILITY | TOTAL 1976 | | PEAK-MONTH | | |
|---|---|---|---|---|---|
| | kj[a] | cu ft | kj | cu ft | |
| Manette | 516,600 | 489,700 | 167,000 | 161,100 | (January) |
| Charleston | 167,500 | 158,800 | 40,900 | 38,800 | (December) |
| Retsil | 65,000 | 61,700 | 11,000 | 10,400 | (February) |
| Total Yearly Usage | 749,300 | 710,200 | | | |

[a] 1 kilojoule (kj) = 0.95 British thermal unit (Btu)

Source: Reference 76.

ties, the methane produced by the anaerobic process is used as fuel to heat the digester, reducing dependence on other fuels (References 1 and 76).

While the Manette treatment plant would be deactivated under Alternative 2, there would be an increase in gas consumption for space heating at both Charleston and Retsil. For example, it is estimated that total heating capacity at the Charleston plant might be increased from the present 790,000 kj [750,000 Btu] to approximately 1,850,000 kj [1,750,000 Btu]. Total heating capacity and gas consumption would be considerably less at Retsil, though increased over present levels (References 1 and 76). The Manchester facility would continue to use fuel oil for space heating until population pressures warrant extending natural gas service to the area. Construction of possibly 100-150 new homes in the area, for example, would justify installation costs. Continued use of anaerobic digesters would still provide methane used for digester tank heating.

Alternative 5 would have approximately the same consumption at Charleston as Alternative 2. Natural gas would not be required at Manette or Retsil. If Alternative 3 is adopted, total gas consumption at Charleston would probably be increased somewhat over the estimate for Alternative 2. Alternative 4 would involve only moderate increases over present levels of usage at Charleston, Manette and Retsil (References 36 and 76).

Cascade Natural Gas Company advises that the anticipated increases in consumption, regardless of whice alternative is chose, would not constitute a significant impact on the gas utility system Reference 76).

Mitigation measures include consideration of the use of methane for space heating at the Charleston, Retsil and Manchester plants to eliminate or reduce the consumption of natural gas and fuel oils.

Electricity. Present annual energy consumption at the five existing treatment plants is shown in Table 32. These figures do not include consumption at the existing pump stations. The two Bremerton plants are served by lines having a total of 28 lift stations, with an average demand of approximately 7 kw. Their total consumption is estimated at 480,000 kwh per year. The Retsil/Port Orchard and Manchester areas have fewer stations with a total estimated consumption of approximately 400,000 kwh per year. Thus, the present total consumption for all existing treatment facilities and auxiliary pump stations is approximately 1.2 million kwh per year (References 45 and 77).

Table 32. PRESENT ANNUAL CONSUMPTION
(March 1976 - March 1977)

| Treatment Plant* | Consumption (kwh/yr) |
|---|---|
| Charleston | 23,360 |
| Manette | 21,960 |
| Port Orchard | 86,484 |
| Retsil | 109,760 |
| Manchester | 60,640 |
| TOTAL: | 302,204 |

---

*Figures do not include existing pumping stations.

Source: References 45 and 77.

Total consumption for Alternative 2 has been estimated at approximately 4.2 million kwh per year. This approximation is based on the year 2000 design flow for a study area population of 89,000, of which approximately 87 percent (78,000) would have sewer service. Implementation of Alternative 2 might therefore increase total electrical consumption by a factor of 3.5, on the basis of the estimate presented in Table 33. Since this figure is based on design flow, it represents a conservative (high) projection.

Estimates of total consumption for the remaining alternatives (3-5) are not available. However, an approximation can be made by comparing recent and earlier estimates for Alternative 2. The total of 4.2 million kwh per year for Alternative 2 (Table 33) reflects recent downward revisions in population projections. In addition, projections of energy consumption have been considerably reduced below earlier estimates as a result of design changes aimed at energy conservation. Table 34 presents an earlier estimate of average demand at design flow for alternatives 2-5 for a sewered population of 85,000 in the year 1990. As indicated by a comparison with Table 33, total consumption for Alternative 2 may be as much as 40 percent less than originally anticipated for a population approximately 8 percent smaller than the earlier projection.

If a similar reduction factor is applied to the 1990 projections for Alternatives 3-5, one can derive order-of magnitude estimates of consumption for these alternatives for a sewered population of 78,000 in the year 2000 (See Table 35).

Table 33. ESTIMATED ENERGY CONSUMPTION, ALTERNATIVE 2, YEAR 2000
(Population served: 78,000)

| Facility | Treatment Plant | | Pumping Stations | | Total | |
|---|---|---|---|---|---|---|
| | Average Demand (kw) | Annual Consumption (mill. kwh/yr) | Average Demand (kw) | Annual Consumption (mill. kwh/yr) | Average Demand (kw) | Annual Consumption (mill. kwh/yr) |
| Charleston | 422 | 2.195 | 90 | 0.465 | 512 | 2.66 |
| Manchester | 43 | 0.283 | - | - | 43 | 0.283 |
| Retail | 160 | 1.195 | 10 | 0.08 | 170 | 1.28 |
| | 625 | 3.673 | 100 | 0.545 | 725 | 4.22 |

Source: Reference 36.

## Table 34. ESTIMATED TOTAL ELECTRICAL POWER DEMAND AND CONSUMPTION, ALTERNATIVES 2-5, YEAR 1990 (Average demand in kw for a population of 85,000)

| Treatment Plant* | Alternatives | | | |
|---|---|---|---|---|
| | 2 | 3 | 4 | 5 |
| Charleston | 520 | 600 | 300 | 520 |
| Manette | - | - | 300 | - |
| Port Orchard | - | - | 95 | - |
| Retsil | 165 | - | 80 | - |
| Manchester | 60 | 60 | 60 | 190 |
| Subtotal | 745 | 660 | 835 | 710 |
| Additional Pumping Stations | | | | |
| Manette to Bremerton | 70 | 70 | - | 70 |
| Port Orchard to Charleston | - | 10 | - | - |
| Port Orchard to Retsil | 5 | - | - | 5 |
| Retsil to Port Orchard | - | 5 | - | - |
| Retsil to Manchester | - | - | - | 50 |
| Subtotal | 75 | 85 | - | 125 |
| TOTAL DEMAND | 820 | 745 | 835 | 835 |
| Total Consumption (million kwh/yr) | 7.2 | 6.6 | 7.4 | 7.4 |

*Figures include pumping stations on existing lines.

Sources: References 1 and 36.

## Table 35. ESTIMATED ENERGY CONSUMPTION, ALTERNATIVES 3-5, YEAR 2000 (Population served: 78,000)

| Alternative | Approximate Total Annual Consumption (million kwh/yr.) |
|---|---|
| 3 | 4.0 |
| 4 | 4.4 |
| 5 | 4.4 |

For purposes of comparison, it is estimated (Reference 36) that if all existing plants were upgraded to provide secondary treatment (Alternative 4), total electricity consumption would be approximately three to four times the present annual total of 1.2 million kwh. The calculation yields a range of 3.6 to 4.8 million kwh/year, which corresponds closely to the estimate in Table 35.

On the basis of the revised population figures, it would appear that all of the proposed alternatives (2-5) would involve significant consumption of electrical energy, totaling 4.0 - 4.4 million kwh/year.

Puget Sound Power and Light Company advised that a total peak demand of up to 5,000 kw could be handled without difficulty by the electric utility (Reference 45). Even on the basis of the earlier average-demand estimates shown in Table 34, it would appear that the proposed project will not have a significant impact, regardless of the alternative adopted.

Mitigation Measures. Energy-efficient facilities design would reduce energy consumption. Original estimates of usage have been cut substantially as a result of design recommendations specifying less power-consumptive processes and alternatives. For example, original plans assumed complete-mix activated sludge processes at all locations (Reference 36). Aerobic digestion was also considered. In addition, it was formerly thought that retaining present combined storm drains and providing greater plant capacity to handle stormwater inflow would be more cost-effective than constructing separate storm drains. Revised plans recommend separating storm and sewer drains for reasons of cost as well as lower energy requirements for pumping (References 36 and 78).

Storm Drain Systems. Combined stormwater and sanitary sewers are being gradually replaced with separate systems throughout the study area. For example, in Bremerton, where the only substantial lengths of combined lines remain, all new development or remodeling projects must provide both storm and sewer drains. The proposed project (Alternatives 2-5) will probably involve one or more major additional projects to install separate stormwater drains, in order to redue or eliminate inflow from this source to the sewage treatment plants. Thus the direct effect of any one of the above alternatives would be to accelerate the separation and upgrading of storm drains. The "No Action" alternative, on the other hand, would result in continue deterioration of the present combined systems, wehre these still exist (References 36 and 78). No mitigation measures are applicable for Alternatives 2-5.

## Recreation Facilities

In general, all the alternatives except the "No Action" alternative would have a beneficial effect on the area's recreational facilities by removing or greatly reducing pollution sources. Specifically, Alternative 2 would provide secondary treatment at Manchester, Retsil and Charleston, with Port Orchard and Manette becoming pump stations. The quality of the effluent discharged into Puget Sound at the Manchester boating pier and into Sinclair Inlet at Annapolis would be greatly improved. The source of pollution at the Port Orchard marina would be removed altogether. The park adjacent to the Manette plant would also benefit from the transformation of that site to a pumping station (with possible retention of the existing plant as a standby facility). The quality of water in Sinclair Inlet, itself a recreational area, would be upgraded.

In addition to the benefits mentioned above, Alternative 3 would replace the Retsil plant with a pump station, improving the boating facilities there. The proposed pipeline from Ross Point, on the south side of Sinclair Inlet, to Retsil would run parallel to the bicycle path planned to follow the shoreline (Reference 38). Neither construction nor maintenance of the pipeline would affect use of the bike path, however, since installation is to be in the tide flats (Reference 36).

Alternative 4 would provide for secondary treatment plants at all existing facility sites. This alternative would improve the quality of receiving waters in the Port Orchard system and offshore at Manchester. Treatment plants and outfall areas would remain near the three boating areas mentioned under Alternative 2. In addition, expansion and upgrading of the Manchester facility would probably involve encroachment into adjacent park lands.

## Mitigation Measures

Expansion plans for the Manchester facility should be compactly designed to minimize any expansion into adjacent park land.

Aesthetic Impact. All five, existing treatment plants are relatively inconspicuous, low-lying, neutral-colored buildings, and the proposed new plants will be of similar designs.

Alternatives 3 and 5 offer an aesthetic improvement in compatibility of land uses, because both alternatives involve reductions in the number of outfall sites and replacement of three treatment plants with pump stations. Alternative 2 also would reduce the number of outfall sites and replace two treatment plants, but it involves replacement of the Retsil plant with a larger facility. Although Alternative 4 involves upgrading or replacing existing facilities, the number of outfall sites and treatment plants will remain the same

Alternatives 3 and 5 offer a slight improvement over existing viewer obstructions at Port Orchard and Retsil. There would be no improvement, and perhaps even a worsening in visual obstructions at Retsil site under Alternative 2, because of the replacement of the existing facility with a larger one. Alternative 4 would offer no improvements in the existing, visually obstructed conditions.

Noise, odors and visible emissions presently occurring will be reduced under all alternatives except no project.

## LONG-TERM INDIRECT IMPACTS

Most of the impacts examined in this section are not mitigable through actions by EPA, thus they should be considered unavoidable. The ramifications of these and other unavoidable adverse impacts will be examined in subsequent sections.

Long-term indirect impacts of Alternatives 2 through 5 would be similar. These impacts would result from construction and operation of residential, commercial, public, institutional and industrial structures, and their attendant infrastructure of roads, utilities and flood control measures. Most new construction would be dependent upon provision of sewage collection and treatment facilities. Because of severe limitations and past problems in many areas, existing residential areas would also require adequate sewage facilities. Lack of these facilities, as in the no action alternative, would limit future construction in the planning areas.

Examination of existing and future land uses within the planning area can yield estimates of the possible indirect impacts that may be attributable to new growth. A general estimate of such impacts is derived from the projected population, proportion of sewered and septic tank usage, number of persons per dwelling, and the number of dwellings per hectare (acre). In the general Bremerton area, a 1975 population of 50,754 persons would grow to 57,900 persons with sanitary sewers in 2000.

In 1975, residences for approximately 12,500 persons were served by individual septic tanks, most of which would be replaced by sewers by 1980 (Reference 1). Therefore, in the period 1975 to 1980, new sewer service would be primarily to existing residences.

In the period 1980-2000, the net new population to be served in the Bremerton area will be approximately 7,174 persons. Assuming an average of three to four persons per dwelling, the total number of new dwellings constructed between 1975 and 2000 would be 1,790-2,390, respectively. With an average density of 10-12 units/ha [4-5 units/ac], approximately 200-300 ha [500-750 ac] of land would be converted from unstructured to residential uses in the Bremerton service area. Additional land would also be required for public facilities, especially roads, and commercial-industrial service and employment uses. A general estimate of 300-600 ha [750-1500 ac] of conversion would occur within the Bremerton service area by the year 2000. Some conversion would involve "in-filling" within open lands of the urban area, while additional open lands around the perimeter of the three basins would also be converted. Table 36 summarizes the population growth, the serviced population and dwellings and the estimated land conversion for the Bremerton, Port Orchard and Manchester-Waterman service areas of the proposed alternatives.

Table 36. PLANNING AREA POPULATION GROWTH AND LAND CONVERSION

| Service area | 1975 total population | 2000 sewered population | Net new population | New dwellings | Converted hectares |
|---|---|---|---|---|---|
| **Bremerton-Wildcat Lake Dyes Inlet** | 50,754 | 57,928 | 7,174[a] | 1794-2391[b] | 150-239[c] |
| **Gorst** | 1,945 | 0 | 0 | 0 | 0 |
| **Port Orchard/ Retsil** | 14,076 | 16,730 | 2,664 | 666-888 | 56-89 |
| **Manchester/Waterman** | 2,525 | 3,288 | 1,763 | 441-588 | 37-59 |

[a] Assumes existing unsewered population would be sewered between 1975 and 2000.

[b] Assumes four to three persons per dwelling, respectively.

[c] Assumes twelve to ten dwelling per hectare, respectively.

The conversion of 490-780 ha [12000-1950 ac] for new residential land uses does not include area for roads, utilities, public areas, commercial areas and industrial employment areas. The overall conversions for future growth would probably involved more than 900 ha [2300 ac] of land within existing sewered areas and system expansion areas.

## Soils and Geology

Future growth and land conversion, permitted by additional sewerage capability, will have indirect effects upon the geological and soil resources of the planning area. Within the Bremerton, Port Orchard/Retsil and Waterman/Manchester areas, a new population of 20,000 persons would require about 5,000 to 6,700 new structures and a new area of about 490-780 [1200-1950 ac]. These new structures would require suitable open land and construction materials, such as sand, aggregate and soil. The demand for these soil and mineral resources will require extraction and mining in other areas of the county and state.

New residential construction of 2,900 to 3,900 dwellings and utilities, roads, public/institutional offices, parks/recreational facilities and commercial structures would produce considerable areas of bare ground during construction and impervious surface during operations. During construction, frequent rain storms could erode the exposed soils and soft bedrock. In early construction phases, sediment may pass into surrounding undisturbed lands and be deposited. However, when storm drains, streets and gutters are in place, eroded sediment would be conveyed directly into the receiving waterbodies. This could result in an annual loss of thousands of cubic metres of soil resource from the upland areas.

During the next 20-25 years, at least one strong tremor may occur in the southern Puget Sound area, following the historic frequency of three strong tremeors in the last 30 years. The increased, structural land uses, such as bridges, underground utilities, storm drains, and residences on steep slopes and waterlogged ground may provide suitable conditions for increases in seismic damages, equal to or greater than that for existing land uses.

## Water Resources

### Surface Water Resources

The most significant effect of growth upon surface water resources will be an increase in impervious surfaces and resultant runoff as more undeveloped land is converted to urban uses. Because Kitsap County's development policies encourage relatively dense forms of development to take place in existing developed and serviced areas, surface water impacts of a greater magnitude will occur in these areas. In addition, these development policies will allow such impacts of lesser magnitude to occur in the developing urban fringe.

An increase in impervious surfaces will lead to greater surface water runoff and subsequent effects on local watersheds and drainage channels. These effects are likely to include stream channel scouring, stream bank and bottom erosion, and gullying. Storm runoff would quickly pass into the creeks by way of gutters, culverts and storm drains, and would increase channel velocities and flood stages in the upland areas. Increased runoff would alter the erosion/deposition balance along some creeks, especially south of Port Orchard. Slight increases in local flooding may cause bank erosion and failures and increased culvert maintenance along Ross, Blackjack, Salmon and Beaver creeks in the Port Orchard/Retsil/Manchester area. Existing culverts near the shore may not have sufficient capacity to pass increased runoff and may cause local flooding. The likelihood and magnitude of local flooding impacts can best be evaluated on a project-by-project basis through Kitsap County's environmental review process.

Other drainage net qualities will be impacted by future development. Construction related erosion will create sediments that will be washed into water courses via runoff. Much of the sediment will settle to the bottoms of channels at various locations and may adversely affect benthic habitats and spawning grounds. Local technical authorities, such as the U.S. Soil Conservation Service, consider this impact to be of short-term significance. This is due to the rapid stabilization of disturbed construction sites by fast-growing vegetation. In addition to sediments, urban debris from construction and subsequent activities can be washed into water courses, clogging flows and possibly creating local flooding problems.

Some chemical and biological water quality problems will continue in the developed area to varying degrees. Fertilizers, pesticides and petroleum products will enter the drainage nets in greater amounts as the development pattern becomes both more dense and more expansive. Malfunctiong septic systems will continue to be a source of pathogens and nutrients in the urbanizing fringe areas until sewer services are extended.

## Developable Water Resources

As noted in the Environmental Setting section, the Bremerton area is expected to face a serious potable water shortage due to the limited reserves provided by local streams and aquifers. Because information and data on the impending shortage are scarce, the following impact assessments should be considered speculative, but worthy of further investigation by appropriate agencies.

As the developed areas of the county have grown, residents have come to rely more on municipal water systems which utilize large pumping capacity wells. These wells are located on the fringe or beyond the developed areas. Through their drawdown characteristics, they can lower water levels in nearby shallow wells, which supply the bulk of potable water to rural areas. Reduction in water supply from shallow aquifers would necessitate new wells to be drilled into the deeper Colvos sand alluvial aquifers, or water-utility connections with a municipal system. In either case, the expense to the individual well user could be considerable.

The future demand for water will likely result in the maximum appropriation of all significant local reserves, as has already occurred in the over-appropriated Chico Creek basin. The demand will also result in the importation of water from outside the study area and Kitsap County. The nearest available outside reserves are Gold and Huge Creeks, which are located to the west and drain towards Hood Canal. Considerations have been made to connect into Tacoma's water supply or to exercise water rights held by the City of Bremerton for the Duckabush and Hamma Hamma Rivers, which are located across Hood Canal on the east slope of the Olympic Range.

As with other urban areas that have demanded more water than their immediate areas could provide, the study areas's future water demand may pose significant consequences to areas outside of its immediate influence. The detailed assessment of these consequences is beyond the scope of this study. However, the development of any new, major water resource for use in the Bremerton/Port Orchard area can and should be subject to environment review through the State Environment Policy Act (SEPA) process. This review should take place at the highest possible level of state government, during the earliest stages of planning. It should define and examine the specific impacts and issues inherent in a given water resource exploitation project and the urban growth that it could accommodate.

## Terrestrial Environment

Creek channel improvements, such as straightening, removal of riparian vegetation and colonization by weeds, severely reduce habitat diversity. The soil erosion impacts discussed earlier affect aquatic habitats by filling in rough creek channel bottoms with silt which eliminates the physical niches necessary to many benthic organisms, thus reducing the stream's biologic carrying capacity.

Continuing and future construction activities are likely to entail creek disturbances, modifications, crossing and riparian vegetation removal. Construction across riparian zones severs the continuity of this habitat, thereby disrupting wildlife movements through it.

The restabilization of creeks disturbed by construction generally takes 1-3 years depending on various factors such as seasonal streamflow, bank stabilization and revegetation efforts. Normal winter rainfall following construction periods leads to high streamflows that scour deposited sediments and detritus. Upstream flows also reintroduce aquatic biota to the depleted systems. Turbidity and sedimentation are severe during initial construction periods but decrease with time as vegetative cover is restored.

Development around pond and marsh areas often disturbs the local habitat quality. The opening of rural and wild lands for residential and increased recreational uses creates pressures on wildlife and their habitats. However, these pressures on habitat would occur to some degree regardless of this project. The long-term result of human encroachment upon wilderness land would mean the adaption of some wildlife and the disappearance of sensitive individuals and species.

## Marine Environment

As the planning area population grows and new lands are developed, non-point pollution sources will also increase. Development generated sediments will eventually be transported and discharged into Sinclair Inlet, Dyes Inlet and Puget Sound. Depending upon the volume and velocity of the water transporting these sediments, silt and other materials will be deposited along the banks and at the mouths of creeks, draining the area. Sediments flowing into Puget Sound should be well dispersed by the strong tidal currents and thus have little or no continuing impact on marine benthic habitats. However, the sediments produced in the major portion of the study area will be discharged into Sinclair and Dyes Inlets where flushing and exchange are relatively poor. Discharged sediments will accumulate to some degree in the shallow sand beaches and mudflats near the mouths of creeks along the west shore of Dyes Inlet and along the west and south shores of Sinclair Inlet from Gorst to Waterman. These transported sediments will contribute to the filling in of shallow waters such as Sinclair Inlet, near Gorst and Chico Bay. Marine benthic habitats will be adversely affected by the sediments and accompanying turbidity.

No original or model-derived baseline data on the predevelopment conditions of the Port Orchard Bay system's water quality are available. Nor, are there any projections or models of the system's future water quality conditions considering both point and non-point pollution sources. Thus, it is impossible, at this time, to quantitatively or qualitatively estimate what affect population growth in the study area will have on the water quality of the Port Orchard Bay system.

The increased nutrients to be found in runoff waters will pose problems for marine fauna and flora. Amounts of nitrogen and phosphorus in shallow, slowing moving waters can initiate or contribute to algal blooms. Areas prone to these algal blooms are the shallow waters of Sinclair Inlet, Dyes Inlet and small bays within the Port Orchard System. Algal blooms are characterized by rapid growth in the spring and summer followed by massive dieoffs as sustaining nutrients are depleted in supporting waters. Nitrogen is especially affected by these algal blooms and its depletion can have adverse impacts upon other forms of marine vegetation which need this nutrient. Effluent discharges will continue to contribute to nitrogen levels during the time of nutrient depletion and dieoff, thus outfalls will have the effect of sustaining algal blooms in the local vicinity during this time.

## Archaeological and Historical Resources

Long-term effects in the study area may involve the destruction and disturbance of archaeological sites either by construction activities or by uncontrolled collection of archaeological remains by local residents. Also, effects may involve the destruction or substantial modifications of historic landmarks and their settings. These effects would probably be concentrated in the East Bremerton, Port Orchard and Manchester areas.

If most development occurs around the perimeter of the existing urban areas, archaeological remains along creeks and shores may be adversely affected. However, many such shore areas have already been converted or are in ownership which may not be subdivided within the project lifetime. This ownership would provide some protection along the shore which have the greatest potential for archaeological remains. Higher upland areas have less potential for archaeological remains, but these areas also have the least existing ownership protection compared to the shore areas. If new land conversion occurs as in-filling of lots within the urban area or by intensification or replacement of existing land uses, fewer archaeological resources would be affected. However, buildings of some local historic interest may be destroyed or substantially modified by renovations. These latter effects may depend directly upon conversion for residential dwellings or may be induced by general growth of the commercial activity associated with an increase of 20,000 residents in the urban area.

## Air Quality

The region's general air quality will remain high despite population growth and its resultant air pollutant emissions. However, in the future, episodic temperature inversions, which occur in the early spring, late summer and early fall, may trap stronger concentrations of air pollutants, thus making a significant contribution to increasingly noticeable photochemical smog.

## Noise

The number of noise sources will increase in the urbanizing portions of the study area as undeveloped lands are converted and roads are constructed to provide access. Suburban areas will not experience a significant increase in ambient noise levels, although occasional construction activities will impact very local areas. The present major noise concentrations, the arterial roadways, will likely become more significant in commercial areas and around job centers if the area's economic activity remains strong.

# SECTION V

# SECTION V

# UNAVOIDABLE ADVERSE IMPACTS

Environmental impacts and feasible measures to mitigate or eliminate adverse effects of each alternative were presented in Section IV. Those impacts that cannot be avoided, even with the implementation of mitigation measures are presented in Table 37. Alternative 1 differs greatly in degree of impacts from the other alternatives. Alternatives 2 through 5, which involve upgrading to a secondary treatment level, have many similar types of impacts. Differences are due mainly to treatment facility and pipeline locations.

## Alternative Plans

### Alternative Plan No. 1 (No Action)

Operation of septic tanks and leach fields in marginal or unsuitable areas would lead to periodic septic system failures, and pollution of surface waters and shallow groundwater aquifers.

Marine water quality in the Sinclair Inlet planning area would continue to be affected by the discharge of wastewater effluent high in coliform bacteria, organic material, suspended solids, dissolved nutrients and, at times, residual chlorine. Areas where water quality and the marine environment will be affected include the shallow waters of Sinclair Inlet near Gorst, Port Orchard, Retsil and to some extent, Dyes Inlet. Long-term pollution effects on the marine environment are reductions in the population of sensitive fish and invertebrate species, overstimulation of nuisance species (i.e. algae) contamination of shellfish resources, public health hazards and deterioration of aesthetic qualities. Continuance of the present discharge system would also be contrary to the goals of P.L. 92-500 and in direction violation of the NPDES discharge limitations.

### Alternative Plan No. 2 (Charleston Regional/Retsil Regional/Manchester

Placement of a proposed pipeline route along roads and established rights-of-way between Manette and Charleston will have significant short-term impacts on traffic, aesthetics and utility services. On the southshore of Sinclair Inlet, pipeline placement in the subtidal and intertidal lands between Port Orchard and Retsil will have negative short-term impacts on small-boat navigation, marine vegetation and benthic communities, marine water quality and aesthetics. Careful construction practices could mitigate these impacts, buth they are

## Table 37. ENVIRONMENTAL SUMMARY OF ADVERSE IMPACTS OF PROJECT ALTERNATIVES FOR THE SINCLAIR INLET SEWERAGE FACILITIES PLAN

| Impacts | No Action 1 | Charleston Regional/ Retail Regional Manchester 2 | Charleston Regional Manchester 3 | Local Treatment Plants 4 | Charleston Regional Manchester Regional 5 |
|---|---|---|---|---|---|
| Soil stability and erosion hazards | ⦶ | ⦶ | ◑ | ◑ | ◑ |
| Potential geological hazards | ⦶ | ⦶ | ⦶ | ◑ | ⦶ |
| Impact on air quality | ○ | ⦶ | ⦶ | ⦶ | ⦶ |
| Odor and noise generation potential | ◑ | ⦶ | ⦶ | ⦶ | ⦶ |
| Direct effects on stream water quality | ● | ⦶ | ⦶ | ○ | ⦶ |
| Degradation of groundwater quality | ● | ⦶ | ⦶ | ⦶ | ⦶ |
| Vegetation and terrestrial wildlife loss | ○ | ⦶ | ⦶ | ⦶ | ◑ |
| Marine water quality impact | ◑ | ⦶ | ⦶ | ⦶ | ⦶ |
| Marine biota (benthic organisms and fisheries) | ◑ | ◑ | ◑ | ◑ | ◑ |
| Stimulation of algal blooms | ● | ◑ | ◑ | ◑ | ◑ |
| Impact on land and property values | ⦶ | ⦶ | ⦶ | ● | ⦶ |
| Loss in property tax revenue | ○ | ⦶ | ⦶ | ● | ⦶ |
| Increase in municipal service costs | ○ | ◑ | ⦶ | ◑ | ◑ |
| Consumptive use of energy | ⦶ | ◑ | ◑ | ⦶ | ◑ |
| Impact on recreation facilities | ⦶ | ○ | ○ | ⦶ | ○ |
| Impact upon aesthetic qualities | ◑ | ⦶ | ⦶ | ◑ | ⦶ |

[a]Degree of Impact:
● Major impact
⦶ Minor impact
◑ Moderate impact
○ No impact

nevertheless unavoidable. Disruption of land use and local patterns would occur with the removal of six homes at the Charleston site.

The major treated effluent submarine outfall would be located in Sinclair Inlet near Charleston at a 12-18 m [40-60 ft] depth. Modeling results indicate that first mixing and dilution of effluent would be fair-to-poor and that subsequent dispersion and flushing would be poor. Initial dilution could provide 100:1 dilution only 25 percent of the time, thus effluent would be diluted poorly. Due to the poor circulation within this inlet, diluted effluent would be the receiving water for more effluent. Secondary-level treated effluent discharged at Charleston and Retsil would improve local water quality compared to the present situation. However, chlorine residual would be a problem for marine life. This alternative represents an immediate solution that best accommodates the existing jurisdictional entities. Pollution effects will be alleviated, but the long-term productivity of the marine environment would not be comparable to the complete cessation of discharge to Sinclair Inlet.

## Alternative Plan No. 3 (Charleston Regional/Manchester)

This alternative involves a regional secondary treatment plant at Charleston consolidating the four treatment plants in the vicinity of Sinclair Inlet. Flows from the Manette facility, Dyes Inlet and Wildcat Lake will be conveyed across Bremerton to the Charleston site. Retsil and Port Orchard flows will probably be conveyed in a submerged pipeline from Retsil west to Ross Point and then across the inlet to Charleston. The facility would be sized to handle an average flow of 0.5 $m^3/s$ [11.7 mgd]. The facilities planner did not designate a specific treatment process. It is presumed that it would be similar to Alternative 2. The Manchester facility will remain independent and will also be upgraded to a 0.02 $m^3/s$ [0.5 mgd] secondary treatment plant similar to Alternative 2.

Pipeline construction in this alternative represents the most significant short-term impact. Land routes for pipelines through downtown Bremerton, Port Orchard, and Bay Street/Beach Drive between Retsil and Port Orchard would cause significant traffic disruption and interference with life styles. Alternative pipeline construction in the subtidal and intertidal lands between Retsil and Ross Point would cause disruptions to the marine community and shoreline areas. Construction effects would probably be the greatest on this alternative due to greater lengths of submerged pipeline route required. Removal of six homes would also be required at the Charleston site.

All treated wastewater flows, except for Manchester, would be discharged to Sinclair Inlet near Charleston. Dilution and flushing conditions are similar to those described in Alternative 2. The volume of effluent discharged at Charleston would be approximately 20 - 25 percent greater than in Alternative 2 and thus would slightly increase the ambient background level of diluted effluent in the inlet. Long-term effects of this discharge are similar to those discussed in Alternative 2.

## Alternative Plan No. 4 (Local Treatment Plants)

Localized construction impacts at each facility will be moderate to significant, depending upon the amount of land required. Significant disruption of land use and local patterns would result from construction at the Manette site which requires the removal of 25 homes. This would also occur to a lesser degree at the Charleston and Port Orchard sites. Land acquisition costs and resultant loss in County property tax revenues are also greatest at the Manette site. The Port Orchard and Manette sites are aesthetically poor locations for a wastewater treatment facilities because of their shoreline location and high visibility.

Discharge of secondary-treated effluent to Sinclair Inlet by the Charleston, Port Orchard and Retsil facilities will undergo similar dilution and dispersion characteristics as in Alternatives 2 and 3. Effluent would disperse slowly with a long residence time in Sinclair Inlet. Effluent discharged at Port Washington Narrows from the Manette facility would achieve good initial dilution due to the strong tidal movements. However, subsequent dispersion into the poorly circulating Sinclair and Dyes Inlets would only contribute to wastewater effects from other discharges. Energy consumption for this alternative, along with Alternative 5 is the greatest.

## Alternative Plan No. 5 (Charleston Regional/Manchester Regional)

Pipeline construction impacts will be the greatest with this alternative due to the extensive pipeline requirements. Pipeline routing through downtown Bremerton will have short-term traffic and circulation effects. Pipeline construction in the subtidal and intertidal lands between Port Orchard, Retsil and Waterman will have significant short-term negative effects on the marine environment, and may include long-term effects in some cases. Damage to the benthic marine environment is unavoidable to some degree.

Effects of effluent discharge from the Charleston facility would be similar to those mentioned under Alternative 2. This alternative would be among the two most energy consumptive systems.

# SECTION VI

# SECTION VI

## IRREVERSIBLE AND IRRETRIEVABLE RESOURCE COMMITMENTS

The creation and construction of a wastewater treatment system for the Sinclair Inlet Sewerage Facilities Planning Area will impose on future generations the necessity for a strong commitment to the maintenance, potential expansion and continuation of the wastewater management systems now being developed. The selection of future alternatives for wastewater collection, treatment and disposal will, to a large extent, be limited by implementation of the selected plan.

Four major commitments of resources have been identified with the implementation of a wastewater treatment facilities plan. The extent of resource commitments varies among the alternatives considered and is discussed below.

### IRREVERSIBLE AND IRRETRIEVABLE ENERGY AND ECONOMIC RESOURCE COMMITMENT

Any wastewater treatment system requires a commitment of energy resources for operation. Alternatives 4 and 5 are the most energy intensive, with the operation of a greater number of treatment facilities in Alternative 4 and longer pumping distances in Alternative 5. Alternatives 2 and 3 require comparatively less energy although demand is still significant for pumping and operation needs. Alternatives 2, 3 and 5 with extensive pumping distances will require increasing amounts of energy as population and thus sewage volume increases. Alternative 1 (no action) will not require additional energy use beyond present conditions.

Natural gas is used for space heating within facilities and to heat digesters. Electricity would be used to power equipment and, in some plants, generate gases for wastewater disinfection. This commitment is permanent for energy expended. However, if a dollar value could be placed upon the improved stream water quality, such commitment of resources could be viewed as transferable.

The proposed project will require permanent commitments of construction materials and a 1 1/2 year commitment of construction workers for a combined value of $16-18 million under Alternatives 2 through 4 and $19 million under Alternative 5. The materials would consist of concrete, steel, fabricated machinery, electrical components, wood forms, framing and pipe. The supply of these materials is not known to be critically short, and their purchase and use would be beneficial to the regional and national economies.

The employment of construction workers for the regional facility would draw on a large labor pool at a time of high national unemployment in the construction trades. These workers would be drawn from Kitsap County as well as from the greater Seattle area. Their employment would be of local and state benefit and would reinvest some portion of their earnings through meals, transportation, lodging and entertainment back into Kitsap County.

## IRREVERSIBLE DESTRUCTION OF SOIL PROFILE

Expansion of the Charleston and Retsil sites under Alternatives 2-5 will require excavation, grading and removal of some amount of the soil resource from the site. The Charleston regional plant would require approximately 24,000 - 43,000 $m^3$ [31,000-56,000 cu yd] of excavation. The Retsil site would require the excavation of approximately 760 $m^3$ [1,000 cu yd]. No estimate of soil disturbance or commitment was made for pipeline construction. The soil profile and characteristics disturbed at each site must be considered to be permanently altered.

## IRREVERSIBLE LOSS OF WILDLIFE HABITAT

Direct alteration and loss of wildlife habitat will be least for Alternative 1 (no-action) and comparatively greater for Alternatives 2-5 which require additional land conversion at the Charleston, Retsil and Manchester sites. In particular, a Charleston regional plant would require 1.3 ha [3.2 ac] of additional land and clearing of some of the perimeter vegetation around the site. The Retsil site would require an additional 0.6 ha [1.4 ac] in the brush and forest area behind the plant, while the Manchester site would require complete forest and brush clearance of 0.6-1.2 ha [1.5-3.0 ac]. Destruction of habitat reduces the carrying capacity of the local ecosystem to some degree and would likely lead to a slight reduction in wildlife numbers.

The secondary impacts of all alternatives include increased population growth and its resultant effects upon the environment. Development of outlying areas would lead to physical habitat degradation such as erosion and functional deterioration of habitats due to barrier construction, excessive noise, alterations in predator-prey relationships, vegetation changes and human presence.

## IRRETRIEVABLE WATER AND NUTRIENT RESOURCE LOSS

During the drought of 1976-1977, considerable attention has been focused upon the use of water and possible uses of reclaimed treated effluents to offset depleted water supplies, primarily for industrial uses. The project would collect, treat and dispose of 16.7 x $10^6$ $m^3$ [4,400 mil gal.] per year. This water is irretrievably lost for future human uses, and such human uses would depend on extracted groundwater or surface runoff. Unfortunately, energy and capital costs to provide the treated water to a limited local industrial or agricultural market would far exceed the costs of extraction from present freshwater sources or of use of marine waters for industrial processes and cooling.

Nutrient resource within the treated wastewater and sludge would also be lost from beneficial reuse. Trace minerals, particularly nitrogen and phosphorus would be disposed in the effluent to marine waters where it would be superimposed upon existing high seasonal levels of dissolved nutrients. Sludge reuse as a fertilizer and soil amendment is a strong consideration. Unless the municipal entity or sanitary district can make the appropriate arrangements, the sludge resource would be disposed to a landfill and irretrievably lost.

# SECTION VII

## SECTION VII

# RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Wastewater generation and the necessary management and disposal of wastewater is a long-term reality. Historically, solutions to the waste management problems have ignored this fact by providing short-term solutions which usually have had cumulative adverse effects over the long-term upon the environment. An appropriate example is the proliferation of numerous individual septic tank and drainfield systems in areas with marginally suitable soils. Failure of septic tank drainfields has contributed to the area-wide non-point source pollution problems. Similarly, the operation of many small primary treatment plants serving only limited areas and discharging without concern to effects upon nearby areas leads to cumulative adverse effects upon the environment over the long-term. The solution to these problems is one of the foremost considerations of the proposed project.

Short-term uses of the Sinclair Inlet area with the proposed project would consist of construction effects along the pipelines routes and at the treatment plants, pump stations and outfalls. Pipeline construction would utilize as much as 17,000 m [56,000 ft] of pipe, hundreds of cubic metres of aggregate, other construction materials, mechanical and electrical equipment energy, labor and capital investment. Two to five treatment plants and outfalls would be expanded, and such expansion would use additional land, hundreds to thousands of cubic metres of aggregate, equipment and materials, large amounts of energy (both electricity and petroleum fuels) and labor. Short-term aerial emissions of exhaust, dust and noise would affect the local air resources. Losses of trees and riparian vegetation at the Charleston and Manchester sites, and losses of soil and sediment in storm water runoff represent other uses of the human environment which would occur over a short-term period. Disruption of traffic and recreational activities would affect social elements of the environment, such as reducing vehicular capacity in Bremerton and along Sinclair Inlet, and displacing recreational use of Evergreen Park and school playgrounds in Bremerton. Facilities would require exclusive uses and limited use easements for lands throughout the life of the project. Treatment plants and pumping stations may visually dominate their residential, commercial and roadside settings. Energy consumption for the pumping station and treatment plants would be direct uses which indirectly require uses of hydroelectric reservoir capacity or of coal, oil and natural gas extraction.

Benefits to the physical environment are common to Alternatives 2-5; but in varying degrees. Failure of septic tank drainfields will no longer occur in sewered areas connected to the treatment facilities. As a consequence, existing pollution of streams, Kitsap Lake and local groundwaters, which are used extensively for potable water supply, will diminish. Pollution of Dyes Inlet and Sinclair Inlet will, in general, be diminished. Health hazards within the study area would be substantially reduced.

The maintenance and enhancement of a long-term productivity within Sinclair Inlet is an important consideration with all of the alternatives. The current state and federal standards define water quality criteria and treatment needs for the planning area. Development of treatment strategies and methods along with implementation programs rests upon the local planning agencies and jurisdictions.

Solutions that seem efficient for long-term productivity at this time might not be viewed as such by 2000. There will be improved technology, greater experience with advanced treatment techniques, and, perhaps, breakthroughs in other technologies which may have great impact on wastewater management.

None of the alternatives considered here can be viewed strictly as a short-term use of the human environment. Any unmitigated adverse impact of an action, no matter how small, will be incorporated into the ecosystem and may be magnified over time. Thus, it is necessary to view the utilization of Sinclair Inlet as receiving media not in terms of short-term use of the human environment, but in its true perspective. An immediate consequence of such a view is that there must be a minimal conflict between effluent disposal practices and environmental productivity. This makes adoption of mitigative provisions enumerated in Section V important under any alternative selected.

The usage of Sinclair Inlet as a long-term receiving water requires additional consideration. Water quality standards stipulate the implementation of secondary treatment level and the attainment of specific water quality parameters. The standards, however, do not specify impact parameters for the biological community or trace toxic materials such as heavy metals or pesticides. Given the present and projected conditions at the Charleston facility, secondary treatment of wastewaters will marginally meet coliform concentration standards the majority of the time. To ensure compliance with the coliform standard, continuous and heavy chlorination would be required to disinfect the effluent. Aside from the cost and the energy to produce the chlorine, EPA has determined that chlorination is not a reliable long-term method for waste treatment. Chlorine concentrations in discharged effluents typically present a greater hazard to the biological marine environment than trace toxic constituents. In addition to chlorine residuals, the poor circulation of the inlet would tend to accumulate the trace wastewater constituents that may adversely affect the marine biological community.

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Based upon these factors, further consideration of long-term wastewater discharge to the marine environment may include the appraisal of other sites beyond Sinclair Inlet that provide adequate flushing without need for heavy chlorination. With proper design and location, wastewater discharges to the marine environment could be made reasonably consistent with the maintenance and enhancement of long-term productivity.

A secondary, related short-term use of the environment is the local growth and land development activity which is a motivating force behind the proposed project. Local development with a degree of outside influence from the Trident project is anticipated in the planning area with or without the proposed project. Development typically brings about loss of vegetative cover, transport of soils and resources, changes in land use and other indirect effects upon the environment. The balance between short-term growth and development and the long-term productivity of the terrestrial environment is subject to question, emphasizing that proper land-use planning and implementation are extremely important.

# SECTION VIII

## Section VIII

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# APPENDICES

A

# APPENDIX A

## WATER QUALITY REGULATIONS AND STANDARDS

The Washington State Department of Ecology (DOE) established water quality standards for all waters in the State of Washington pursuant to the Federal Water Pollution Control Act of 1965. The standards included a general classification of water courses consistent with present and anticipated water uses considering existing water quality, together with water quality criteria or limits on the values of important physical, chemical and biological characteristics for each water course class, as well as implementation and enforcement requirements for existing waste discharges. In addition to the water quality standards, the State of Washington has declared an antidegradation policy which says, in part, that whenever the natural conditions are of a higher quality than the criteria assigned, the natural conditions shall constitute the water quality criteria (Reference A-1).

Washington State waters are classified into five categories ranging from class AA Extraordinary to class C Fair, with a special "lake" category established for lakes and impondments. Table A-1 lists the classes of surface water in the study area and its surroundings.

Table A-1. CLASSIFICATION OF SURFACE WATERS IN THE STUDY AREA

| Water body | Assigned class |
|---|---|
| Puget Sound | AA |
| Except Dyes and Sinclair Inlets, west of longitude 122°37'W and south of latitude 47°35'20"N | A[a] |
| All lakes | LAKE |
| All lake feeder streams | AA |
| All other surface waters | A |

[a] Water quality shall conform to the standards for this class with the following Special Conditions: total coliform organisms shall not exceed median values of 1,000 with less than 20 percent of samples exceeding 2,400 when associated with any fecal source.

Source: Reference A-1.

Some of the more significant water quality criteria are shown in Table A-2. These standards apply throughout the water body except within a limited initial mixing zone surrounding a wastewater discharge in marine waters (Reference A-2).

Table A-2. WASHINGTON WATER QUALITY STANDARDS

| Characteristic | Unit | Class<br>AA Extraordinary | <br>A Excellent |
|---|---|---|---|
| Total coliform | MPN/100 ml | <70 | <70 |
| Dissolved oxygen | mg/l | >7.0 | >6.0 |
| pH | pH | 7.0 - 8.5 | 7.0 - 8.5 |
| Temperature | °F | <55 | <61 |

Within the initial mixing zone surrounding a wastewater discharge, State of Washington standards prohibit acute biological shock, which means "that does or circumstance which has been demonstrated by field or laboratory observation to directly result in mortalities of food, game, or commercial fish species".

In order to meet the water quality standards, point sources of wastewater are regulated by means of the National Pollutant Discharge Elimination System (NPDES) or permit system. Permits define the minimum quality of discharge effluent that will maintain compliance with water quality standards. Under the provisions of the Federal Water Pollution Control Act Amendments of 1972, publicly-owned treatment plants must provide at least secondary treatment by mid-1977 and Best Practicable Waste Treatment Technology (BPWTT) by mid-1983. Secondary treatment is defined numerically as shown in Table A-3. Within the Sinclair Inlet portion, the NPDES limitations are further defined to require 85 percent removal from present conditions. These slightly more restrictive requirements are also shown in Table A-3 for each facility. Best Practicable Waste Treatment Technology is presently defined as secondary treatment plus any additional treatment required to meet water quality standards. Thus it is apparent that all alternatives will require secondary treatment; however, some may require further treatment in order to meet water quality standards.

Recently, EPA proposed a change in the regulations defining secondary treatment; the change involved elimination of the fecal coliform standard. The implication of the proposed change is that in view of potential environmental and public health problems associated with chlorination, the most commonly used disinfection method, the bacteriological requirements for effluent discharge should be established on a case-by-case basis.

## Table A-3. FEDERAL SECONDARY TREATMENT EFFLUENT REQUIREMENTS

| Secondary effluent requirements | $BOD_5$[a] (mg/1) | SS[b] (mg/1) | Fecal coliform no/100 ml | pH |
|---|---|---|---|---|
| All Municipal Facilities, General Requirements | | | | |
| Monthly average | 30 | 30 | 200[c] | 6.5-8.5 |
| Weekly average | 45 | 45 | 400[c] | 6.5-8.5 |
| Bremerton Facilities | | | | |
| Charleston (Monthly) average) | 20 | 20 | | |
| Manchester (Monthly average) | 20 | 20 | | |
| Port Orchard (Monthly average) | 25 | 25 | | |
| KCSD No. 3-Manchester (Monthly average) | 25 | 25 | | |
| KCSD No. 5-Retsil (Monthly average) | 25 | 25 | | |

[a] Five day biochemical oxygen demand

[b] Suspended solids

[c] Geometric mean

References:

A-1 State of Washington Water Quality Standards
Effective 19 July 1973; Amended 20 August 1973,
Washington Administrative Code (WAC)
Chapter 173-201 WAC

A-2 Environmental Protection Agency
Final Environmental Impact Statement for Wastewater Facilities, Kitsap County, Washington, Prepared by Engineering-Science, Inc., and Socio-Economic Systems, Inc. for Environmental Protection Agency, Region X, Seattle, Washington, 1976.

# APPENDIX B

# BIOLOGICAL TERRESTRIAL ENVIRONMENT

## B-1 BIOTIC COMMUNITIES

### Coniferous Forest

The Coniferous Forest unit on the Kitsap Peninsula is dominated by Douglas-fir, primarily because of climate and human activity in Puget Sound. Although western hemlock is considered to be the climax species in this coastal vegetation zone, Douglas-fir is better adapted to local climatic conditions such as less precipitation, hotter summers (and thus more evaporative stress) and a shorter growing season (because of colder winters). Additionally, Douglas-fir is a pioneer species, becoming established in open conditions after logging, fire, land-clearing or other land disturbances. Other major tree species found within this unit are western hemlock, western redcedar, western white pine and red alder. Salal, ocean spray and evergreen huckleberry are among the major shrubs, with shade-tolerant herbs and ferns comprising the understory. Animal life in this community is abundant, harboring many nut- and insect-eating birds such as chickadees, nuthatches, creepers and jays. Larger birds include the blue and ruffed grouse and predators such as Cooper's hawk and screech owls. Mammals include several species that occur in more than one habitat, such as the black bear, coyote, raccoon and red-backed vole.

### Broadleaf Forest

The growth and development of deciduous hardwood forests is generally limited by climatic conditions. The mild Washington coastal winters enable coniferous species to continue tissue growth at a time when the deciduous trees are dormant. The relatively dry summers are also unfavorable to broadleaf trees, which must channel large amounts of energy and nutrients toward foliage production at a time when evaporative stress is high. Consequently, within Kitsap County, deciduous trees and shrubs are more common in lowland areas which retain higher soil moisture. The impact of human activities over the years has stimulated and broadened the range of the Broadleaf Forest. Fast-growing deciduous vegetation invades and successfully competes with conifers in recently cleared areas, second-growth zones and urban and auto traffic areas. Deciduous vegetation is also aided and stimulated by human activities such as irrigation and on-site disposal systems.

Red alder is a pioneer species on moist, disturbed land, and bigleaf maple is a major component of the Broadleaf Forest unit. Other tree species include cascara, Pacific willow, madrona, western hemlock and Douglas-fir. Understory species are salmonberry, blackcap, red elderberry and sword fern, as well as common herbaceous species.

The Broadleaf Forest habitat generally has a lower tree canopy and more intermittent open areas than does the Coniferous Forest. The thicker understory of flowering vines, berries and shrubs in the Broadleaf Forest is attractive to many fruit- and seed-eating birds, such as mourning doves, juncoes, migratory warblers, thrushes and sparrows. In addition to the larger mammals mentioned in the discussion of the Coniferous Forest, smaller fruit- and seed-eating mammals such as striped skunk, cottontail rabbit, townsend chipmunk and deer mouse are prevalent. Under rocks and rotting logs are found several salamander species: rough-skinned newt, northern alligator lizard and northwestern garter snake.

## Mixed Coniferous/Broadleaf Forest

Much of the forested land within the study area contains a mixture of the major coniferous and broadleaf species found in each of those respective units. Soil moisture and human activity are the primary factors allowing the establishment of hardwoods among conifers. Major tree species are Douglas-fir, western redcedar, bigleaf maple, Pacific dogwood, red alder and western hemlock. This unit contains some open upland areas that are being invaded by Scotch broom, red alder, willow, madrona and Douglas-fir. The understory is lush, containing thick growths of salal, red elderberry, Indian plum, swamp gooseberry, blackcap, salmonberry, sword fern and common herbaceous species. The fire potential in this unit is extremely high since in many areas there is a continuous layer of fuel from ground to canopy.

Riparian vegetation along perennial creeks and watercourses can be considered a sub-unit within the Mixed Coniferous-Broadleaf Forest. This vegetation has a continuous supply of water that supports thick vegetative growth and moisture-loving species. Major tree species found in riparian zones are western redcedar, vine maple, red alder, bigleaf maple and western hemlock. Dense growths of shrubs and herbs, such as devil's club, blackcap, thimbleberry, stinging nettle, skunk cabbage, sword fern and bracken fern, are found along with other characteristic species. Birds particularly favoring the riparian habitat are mourning dove, olive-sided and Traill's flycatchers, Bewick wren, all vireos, song sparrow and many warblers. Amphibians such as boreal toad, rough-skinned newt and salamander, which occur seasonally in many habitats, all return to the water habitat to mate and spawn. Mammals frequenting the riparian habitat include the raccoon, woodrat, deer mouse, all shrews and most bats.

## Pasture/Meadow

The pastures and meadows within the study area are fairly open areas primarily under agricultural use. Woody vegetation scattered throughout and on drier margins includes red alder, willow, Douglas-fir and western white pine. The meadow species include a variety of grasses, salmonberry, blackcap, ox-eye daisy, sword fern, rushes, self-heal, buttercup and other common species. Land areas utilized as rural residences and developments are also included within this unit. Grazing, agriculture and residential activity serve to check the invasion of the drier areas by brush and woody species.

The Pasture/Meadow habitat generally is favored by seed-eating birds such as western meadowlark, mourning dove, Brewer's blackbird and savannah sparrow. Secretive and burrowing mammals such as white-footed mouse, Pacific jumping mouse and pocket gopher would be common. Varying with the degree of moisture, the boreal toad and garter snake are also found.

## Freshwater Marsh

An upland marsh area created by springs and a high water table may be found in areas such as the head of Beaver Creek west of Manchester. The marsh is probably associated with the Alderwood soil series, which is characterized as a soil with a cemented hardpan in the lower part of the soil profile. This hardpan is impervious, preventing penetration by plant roots and water. Since it is an area of subdued gradient, a temporary or perched water table exists, to create marsh conditions. This wet lowland area supports a variety of grasses, rushes, cattails, horsetails, skunk cabbage and watercress, with occasional red alder, willow and Douglas-fir in the drier areas.

Marsh habitat animals may include red-winged blackbird, killdeer, barn and cliff swallows, fox and song sparrows, vagrant and other water shrews, raccoon, Pacific treefrog and red-legged frog.

### Residential

The area in the vicinity of Bremerton is characterized as residential and/or urban. Vegetation within this unit consists of native and exotic species growing in lawns, gardens and orchards and along roadsides and other locales. Common animals include the robin, mockingbird, house sparrow, house finch, barn and cliff swallows, boreal toad, garter snake and occasional raccoon and black-tailed deer.

### Marine Shoreline

Sand-gravel-cobble beaches are typical of most shorelines in Puget Sound. The extend of the beach area is dependent upon the amount of beach drift material, current strength and degree of wave action. Minimal or no back beach areas on eroded shores occur along the eastern Mannette Peninsula. These shorelines have steep slopes and bluffs resulting from a constant undercutting wave action. Vegetation may hang over the water, or slides may occur that expose the underlying soil. On the other hand, accreted shorelines with moderate to extensive back beach areas are divided into two zones: the upper zone, generally consisting of heavier materials, with moderate to steep slope; and the lower zone, generally consisting of lighter materials and a shollow slope.

Shore vegetation found on the beach and upper beach areas is exposed to the air but requires a saline water environment. Pickleweed, cord grass, cat's ear, rush and bulrush are common in the shore area. These beach plants are often found on protected accreting shorelines which provide a gravel back beach area of sufficient width for the plants to survive and germinate. Cord grass, rush and pickleweed help to stabilize accreted shorelines and act as a barrier system against severe storms which erode shorelines. This shore vegetation also provides food and shelter for migratory waterfowl, shorebirds and other shoreside animals, as well as for juvenile fish.

The predominant wildlife covers a wide range of shorebirds and waterfowl. Resident species include killdeer; great blue heron; sandpiper; yellowleg; dabbling ducks such as mallards, green-winged teal, American widgeon; diving ducks such as bufflehead, goldeneye and red-breasted merganser; and various gulls. The primary food items for these birds are the associations of small crustaceans, worms and molluscs in the interstices of gravel, cobble and sand.

## Appendix B-2

## PRINCIPLE PLANT SPECIES AND OCCURRENCE WITHIN STUDY AREA

| Common name | Scientific name | Biotic communities<br>Coniferous Forest<br>1 | Broadleaf Forest<br>2 | Mixed Coni.-Broad.<br>3 | Pasture-Meadow<br>4 | Freshwater Marsh<br>5 | Residential<br>6 | Marine Shoreline<br>7 |
|---|---|---|---|---|---|---|---|---|
| **Trees** | | | | | | | | |
| Alder, red | *Alnus rubra* | x | x | x | x | x | | |
| Adler, Sitka | *Alnus sinuata* | | | x | | | | |
| Bitter cherry | *Prunus emarginata* | | x | x | | | | |
| Black hawthorn | *Crataegus douglasii* | x | | | | | | |
| Cascara | *Rhamnus purshiana* | | x | x | | | | |
| Douglas-fir | *Pseudotsuga menziesii* | x | x | x | | x | x | |
| Madrona | *Arbutus menziesii* | | x | x | | | | |
| Maple, bigleaf | *Acer macrophyllum* | x | x | x | | | x | |
| Maple, vine | *Acer circinatum* | | | x | | | | |
| Pacific crabapple | *Malus diversifolia* | | x | x | | | | |
| Pacific dogwood | *Cornus nuttallii* | x | x | x | x | | | |
| Pacific willow | *Salix lasiandra* | | x | x | x | x | | |
| Pacific yew[a] | *Taxus brevifolia* | x | | x | | | | |
| Western hemlock | *Tsuga heterophylla* | x | x | x | | | | |
| Western redcedar | *Thuja plicata* | x | | x | | | | |
| Western white birch | *Betula papyrifera* | | | x | x | | | |
| Western white pine | *Pinus monticola* | x | x | x | | | | |
| **Shrubs** | | | | | | | | |
| Blackberry, evergreen | *Rubus laciniatus* | | x | x | | | x | |
| Blackberry, Pacific | *Rubus ursinus* | x | x | x | | | | |
| Blackberry, trailing | *Rubus vitifolius* | | | x | x | | | |
| Blackcap | *Rubus leucodermis* | x | x | x | x | | | |
| Devil's club | *Oplopanax horridus* | | | x | | | | |
| Hardhack | *Spiraea douglasii* | x | x | x | | | | |
| Hazel | *Corylus cornuta var. californica* | | x | x | | | | |
| Honeysuckle, orange | *Lonicera ciliosa* | x | x | x | | | | |
| Honeysuckle, purple | *Lonicera hispidula* | | | x | | | | |
| Huckleberry, evergreen | *Vaccinium ovatum* | x | | x | | | | |
| Huckleberry, red | *Vaccinium parvifolium* | x | x | x | | | | |
| Indian plum | *Osmaronia cerasiformis* | x | x | x | | | x | |
| Ninebark | *Physocarpus capitatus* | | x | x | | | | |
| Ocean spray | *Holodiscus discolor* | x | x | x | | | x | |

PRINCIPLE PLANT SPECIES AND OCCURRENCE WITHIN STUDY AREA (CONT'D)

| Common name | Scientific name | Biotic communities<br>Coniferous Forest<br>1 | Broadleaf Forest<br>2 | Mixed Coni.-Broad.<br>3 | Pasture-Meadow<br>4 | Freshwater Marsh<br>5 | Residential<br>6 | Marine Shoreline<br>7 |
|---|---|---|---|---|---|---|---|---|
| **Shrubs**, cont'd | | | | | | | | |
| Oregon grape | *Mahonia nervosa* | x | | x | x | | | |
| Red currant | *Ribes sanguineum* | x | x | x | | | | |
| Red rhododendron | *Rhododendron macrophyllum* | x | x | x | | | x | |
| Redberry elder | *Sambucus callicarpa* | | x | x | x | | | |
| Rose | *Rosa* sp. | x | x | x | | | | |
| Rose, wood | *Rosa gymnocarpa* | x | | x | | | | |
| Salal | *Gaultheria shallon* | x | x | x | | | | |
| Salmonberry | *Rubus spectabilis* | | x | x | x | | | |
| Scotch broom | *Cytisus scoparius* | x | x | x | | | x | |
| Swamp gooseberry | *Ribes lacustre* | | x | x | | | | |
| Thimbleberry | *Rubus parviflorus* | x | x | x | | | | |
| Twin-flower | *Linnaea borealis* | x | | x | | | | |
| Waxberry | *Symphoricarpos albus* | | x | x | | | | |
| Willow, Hooker | *Salix hookeriana* | | | | x | x | | |
| Willow, Scouler | *Salix scouleriana* | x | | x | | | | |
| Willow, Sitka | *Salix sitchensis* | | x | | | x | | |
| **Herbs** | | | | | | | | |
| Agoseris | *Agoseris* sp. | | | x | x | | | |
| Bedstraw | *Galium boreale* | | x | x | | | | |
| Bulrush | *Scirpus* sp. | | | | | | | x |
| Bur-clover | *Medicago hispida* | | | | | | x | |
| Buttercup, creeping | *Ranunculus repens* | | | x | x | | | |
| Buttercup, western | *Ranunculus occidentalis* | | | x | x | | | |
| Cat-tail | *Typha latifolia* | | | | | x | | |
| Chamomile | *Anthemis* sp. | | | | | | x | |
| Clover | *Trifolium* sp. | | | x | x | | x | x |
| Common horsetail | *Equisetum arvense* | | | x | | x | x | |
| Common St. Johnswort | *Hypericum perforatum* | | | x | | | x | |
| Curly dock | *Rumex crispus* | | x | x | | | x | x |
| Drummond rush | *Juncus drummondii* | | | | x | x | | x |
| False Solomon's seal | *Smilacina amplexicaulis* | | | x | | | | |

## PRINCIPLE PLANT SPECIES AND OCCURRENCE WITHIN STUDY AREA (CONT'D)

| Common name | Scientific name | Biotic Communities<br>Coniferous Forest<br>1 | Broadleaf Forest<br>2 | Mixed Coni.-Broad.<br>3 | Pasture-Meadow<br>4 | Freshwater Marsh<br>5 | Residential<br>6 | Marine Shoreline<br>7 |
|---|---|---|---|---|---|---|---|---|
| **Herbs, cont'd** | | | | | | | | |
| Field mint | *Mentha arvensis* | | | | x | | | |
| Fireweed | *Epilobium angustifolium* | x | x | x | x | | | |
| Forget-me-not | *Myosotis* sp. | | | x | | | | |
| Foxglove | *Digitalis purpurea* | | | x | x | | x | |
| Gumplant | *Grindelia* sp. | | | | | | x | |
| Hairy cat's ear | *Hypochaeris radicata* | | | x | | | x | x |
| Lupine | *Lupinus* sp. | | | x | | | | |
| Monkey flower | *Mimulus* sp. | | x | x | x | x | | |
| Morning glory | *Convolvulus* sp. | | | | | | x | |
| Mountain sweetroot | *Osmorhiza chilensis* | x | | x | | | | |
| Ox-eye daisy | *Chrysanthemum leucanthemum* | | | x | x | | | |
| Pea, beach | *Lathyrus maritimus* | | | | | | | x |
| Pea, purple | *Lathyrus nuttallii* | | | | | | x | |
| Pickleweed | *Salicornia virginica* | | | | | | | x |
| Plantain, common | *Plantago major* | | x | x | | | | |
| Plantain, English | *Plantago lanceolata* | | | x | x | | x | x |
| Prickly lettuce | *Lactuca serriola* | | | | | | x | |
| Self-heal | *Prunella vulgaris* ssp. *lanceolata* | | | | x | | | |
| Siberian miner's lettuce | *Claytonia sibirica* | x | x | x | | | | |
| Silver beachweed | *Franseria chamissonis* | | | | | | | x |
| Skunk cabbage | *Lysichitum americanum* | | | x | | x | | |
| Small-flower alumroot | *Heuchera micrantha* | | | x | | | | |
| Snakeroot | *Sanicula* sp. | x | | x | | | | |
| Spring gold | *Lomatium utriculatum* | | | x | | | x | |
| Starflower | *Trientalis latifolia* | | x | x | x | x | | |
| Stinging nettle | *Urtica lyallii* | | x | x | | | | |
| Thistle | *Cirsium* sp. | x | x | x | | | x | |
| Vetch | *Vicia* sp. | | | | | | x | |
| Violet | *Viola* sp. | | | x | | | | |
| Watercress | *Rorippa nasturtium-aquaticum* | | | x | | x | | |
| Western trillium | *Trillium ovatum* | | | x | | | | |

## PRINCIPLE PLANT SPECIES AND OCCURRENCE WITHIN STUDY AREA (CONT'D)

|  |  | Biotic Communities |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| Common name | Scientific name | Coniferous Forest 1 | Broadleaf Forest 2 | Mixed Coni.-Broad. 3 | Pasture-Meadow 4 | Freshwater Marsh 5 | Residential 6 | Marine Shoreline 7 |
| **Herbs**, cont'd |  |  |  |  |  |  |  |  |
| Wild Lily of the valley | *Maianthemum dilatatum* |  |  | x |  |  |  |  |
| Yarrow | *Achillea millefolium* |  |  |  | x |  |  | x |
| Youth-on-age | *Tolmiea menziesii* | x |  | x |  |  |  |  |
| **Ferns** |  |  |  |  |  |  |  |  |
| Bracken | *Pteridium aquilinum var. pubescens* | x | x | x | x |  | x |  |
| Lady | *Athyrium filex-femina* |  | x | x |  |  |  |  |
| Licorice | *Polypody* sp. |  | x | x |  |  |  |  |
| Sword | *Polystichum munitum* | x | x | x | x |  | x |  |
| **Grass** |  |  |  |  |  |  |  |  |
| Alkali cordgrass | *Spartina gracilis* |  |  |  |  |  |  | x |
| Bentgrass | *Agrostis* sp. |  |  |  |  |  | x |  |
| Bluegrass | *Poa* sp. |  |  |  |  |  | x |  |
| Fescue | *Festuca* sp. |  |  |  |  |  | x |  |
| Fescue, western | *Festuca occidentalis* |  |  |  |  |  | x |  |
| Perennial ryegrass | *Lolium perenne* |  |  |  |  |  | x |  |
| Prairie wedgegrass | *Sphenopholis obtusa* |  |  |  |  |  | x |  |
| Wheatgrass | *Agropyron* sp. |  |  |  |  |  | x |  |
| Wildrye, blue | *Elymus glaucus* |  |  |  |  |  | x |  |
| Wildrye, dune | *Elymus mollis* |  |  |  |  |  | x |  |

[a] Not observed, but reported to occur.

## Appendix B-3

## COMMON BIRDS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA

| Common name | Scientific name | Biotic communities<br>Coniferous Forest 1 | Broadleaf Forest 2 | Riparian/Lakes 3 | Pasture-Meadow 4 | Marsh/Brackish 5 | Residential 6 | Marine Shoreline 7 |
|---|---|---|---|---|---|---|---|---|
| **Water-associated birds** | | | | | | | | |
| Common loon | *Gavia immer* | | | O | | | | C |
| Arctic loon | *Gavia artica* | | | | | | | O |
| Horned grebe | *Podiceps auritus* | | | O | | | | C |
| Western grebe | *Aechmophorus occidentalis* | | | O | | | | C |
| Eared grebe | *Podiceps caspicus* | | | | | | | O |
| Pied-billed grebe | *Podilymbus podiceps* | | | | | | | O |
| Red-necked grebe | *Podiceps grisegna* | | | | | | | C |
| Double-breasted cormorant | *Phalacrocorax auritus* | | | | | | | C |
| Brandt's cormorant | *Phalacrocorax penicillatus* | | | | | | | C |
| Pelagic cormorant | *Phalacrocorax pelagicus* | | | | | | | C |
| White pelican | *Pelecanus erythrorhynchos* | | | | | | | O |
| Great blue heron | *Ardea herodias* | | | O | | C | | C |
| Green heron | *Butorides virescens* | | | | | | | O |
| Snowy egret | *Leucophoyx thula* | | | | | O | | O |
| American bittern | *Botaurus lentiginosus* | | | O | | | | O |
| Whistling swan | *Olor columbianus* | | | O | | | | O |
| Canada goose | *Branta canadensis* | | | | | O | | |
| Black brant | *Branta nigricans* | | | | | | | C |
| White-fronted goose | *Anser albifrons* | | | | | | | O |
| Snow goose | *Chen hyperborea* | | | | | O | | |
| Mallard | *Anas platyrhyncos* | | | C | | | | C |
| Pintail | *Anas acuta* | | | O | | | | C |
| Green-winged teal | *Anas carolinensis* | | | C | | | | C |
| Blue-winged teal | *Anas discors* | | | O | | | | O |
| Cinnamon teal | *Anas cyanoptera* | | | O | | | | O |
| European widgeon | *Mareca penelope* | | | | | | | O |
| American widgeon | *Mareca americana* | | | O | | | | C |
| Shoveler | *Spatula clypeata* | | | O | | O | | |
| Redhead | *Aythya americana* | | | | | | | O |
| Canvasback | *Aythya valisineria* | | | | | | | O |
| Greater scaup | *Aythya marila* | | | | | | | C |
| Lesser scaup | *Aythya affinis* | | | | | | | O |
| Common goldeneye | *Bucephala clangula* | | | O | | | | C |
| Barrow's goldeneye | *Bucephala islandica* | | | O | | | | C |
| Bufflehead | *Bucephala albeola* | | | O | | | | C |
| Oldsquaw | *Clangula hyemalis* | | | | | | | O |
| White-winged scoter | *Melanitta deglandi* | | | | | | | O |
| Surf scoter | *Melanitta perspicillata* | | | | | | | O |
| Common scoter | *Oidemia nigra* | | | | | | | C |
| Ruddy duck | *Oxyura jamaicensis* | | | O | | | | O |
| Hooded merganser | *Lophodytes cucullatus* | | | O | | | | O |
| Common merganser | *Mergus merganser* | | | O | | | | O |
| Red-breasted merganser | *Mergus serrator* | | | C | | | | C |
| American coot | *Fulica americana* | | | C | | | | C |

## COMMON BIRDS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA (CONT'D)

| Common name | Scientific name | Biotic communities<br>Coniferous Forest<br>1 | Broadleaf Forest<br>2 | Riparian/Lakes<br>3 | Pasture-Meadow<br>4 | Marsh/Brackish<br>5 | Residential<br>6 | Marine Shoreline<br>7 |
|---|---|---|---|---|---|---|---|---|
| **Water-associated birds (cont'd)** | | | | | | | | |
| Semipalmated plover | *Charadrius semipalmatus* | | | | O | | | |
| Killdeer | *Charadrius vociferus* | | | | O | O | | C |
| Black-bellied plover | *Squatarola squatarola* | | | | | O | | |
| Common snipe | *Capella gallinago* | | | | | | | C |
| Whimbrel | *Numenius phaeopus* | | | | | O | | O |
| Spotted sandpiper | *Actitis macularia* | | | | | | | C |
| Greater yellow legs | *Totanus melanoleucus* | | | | | O | | C |
| Lesser yellowlegs | *Totanus flavipes* | | | | | C | | C |
| Pectoral sandpiper | *Erolia melanotos* | | | | | O | | |
| Baird's sandpiper | *Erolia bairdii* | | | | | O | | |
| Least sandpiper | *Erolia minutilla* | | | | | | | C |
| Dunlin | *Erolia alpina* | | | | | | | C |
| Short-billed dowitcher | *Limnodromus griseus* | | | | | | | C |
| Long-billed dowitcher | *Limnodromus scolopaceus* | | | O | | O | | O |
| Western sandpiper | *Ereunetes mauri* | | | | | | | C |
| Sanderling | *Crocethia alba* | | | | | | | O |
| Northern phalarope | *Lobipes lobatus* | | | | | | | O |
| Parasitic jaeger | *Stercorarius parasiticus* | | | | | | | O |
| Glaucus-winged gull | *Larus glaucescens* | | | | | | | C |
| Herring gull | *Larus argentatus* | | | | | | | O |
| Thayer's gull | *Larus thayeri* | | | | | | | C |
| California gull | *Larus californicus* | | | | | | | C |
| Ring-billed gull | *Larus delawarensis* | | | | | | | C |
| Mew gull | *Larus canus* | | | | | | | C |
| Franklin's gull | *Larus pipixcan* | | | | | | | O |
| Bonaparte's gull | *Larus philadelphia* | | | | | | | C |
| Common tern | *Sterna hirunda* | | | | | | | C |
| Caspian tern | *Hydroprogne caspia* | | | | | | | C |
| **Land-associated birds** | | | | | | | | |
| Turkey vulture | *Cathartes aura* | C | C | | C | O | | |
| Cooper's hawk | *Accipiter cooperii* | O | C | O | | | | |
| Red-tailed hawk | *Buteo jamaicensis* | O | O | O | C | | | |
| Bald eagle | *Hiliaeetus leucocephalus* | | | O | | | | O |
| Marsh Hawk | *Circus cyaneus* | | | | C | C | | C |
| Sparrow hawk | *Falco sparverius* | | | | O | O | | |
| Blue grouse | *Dendragapus obscurus* | O | | | | | | |
| Ruffed grouse | *Bonasa umbellus* | O | O | | | | | |
| California quail | *Lophortyx californicus* | | | O | O | | | |
| Mountain quail | *Oreortyx pictus* | | O | O | | | | |
| Ring-necked pheasant | *Phasianus colchicus* | | | | O | O | | |
| Band-tailed pigeon | *Columba fasciata* | C | O | O | | | | |
| Mourning dove | *Zenaidura macroura* | | | O | C | O | C | |
| Barn owl | *Tyto alba* | | | | O | | O | |

## COMMON BIRDS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA (CONT'D)

| Common name | Scientific name | Biotic communities | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Coniferous Forest 1 | Broadleaf Forest 2 | Riparian/Lakes 3 | Pasture-Meadow 4 | Marsh/Brackish 5 | Residential 6 | Marine Shoreline 7 |
| **Land-associated birds (cont'd)** | | | | | | | | |
| Screech owl | *Otus asio* | | O | C | | | O | |
| Short-eared owl | *Asio flammeus* | | | | O | C | O | |
| Anna's hummingbird | *Calypte anna* | | O | O | | | | |
| Rufous hummingbird | *Selasphorus rufus* | O | O | C | | | | |
| Belted kingfisher | *Megaceryle alcyon* | | | O | | O | | O |
| Red-shafted flicker | *Colaptes cafer* | C | C | | | | O | |
| Hairy woodpecker | *Dendrocopos villosus* | C | | O | | | | |
| Downy woodpecker | *Dendrocopos pubescens* | | C | O | | | O | |
| Say's phoebe | *Sayornis sayos* | | | O | O | | O | |
| Traill's flycatcher | *Empidonax traillii* | | O | C | | | | |
| Western flycatcher | *Empidona difficilis* | C | | O | | | | |
| Olive-sided flycatcher | *Nuttallornis borealis* | C | C | C | | | | |
| Horned lark | *Eremophila alpestris* | | | | C | O | | |
| Violet-green swallow | *Tachycineta thalassina* | | O | O | O | | O | |
| Barn swallow | *Hirundo rustica* | | | | C | C | C | O |
| Cliff swallow | *Petrochelidon pyrrhonota* | | | | O | O | C | |
| Steller's jay | *Cyanocitta stelleri* | C | | O | | | O | |
| Common crow | *Corvus caurinus* | | | | C | O | O | |
| Black-capped chickadee | *Parus atricapillus* | | O | C | | | C | |
| Chestnut-backed chickadee | *Parus rufescens* | C | | C | | | | |
| Common bushtit | *Psaltriparus minimus* | O | | C | | | C | |
| Red-breasted nuthatch | *Sitta canadensis* | C | | | | | | |
| Brown creeper | *Certha familiaris* | C | | | | | | |
| Dipper | *Cinclus mexicanus* | | | O | | | | |
| Bewick's wren | *Thryomanes bewickii* | | O | O | | O | C | O |
| Robin | *Turdus migratorius* | | | | C | | C | |
| Varied thrush | *Ixoreus naevius* | C | | | | | | |
| Swainson's thrush | *Hylocichla ustulata* | | C | C | | | | |
| Townsend's solitaire | *Myadestes townsendi* | C | | | | | | |
| Golden-crowned kinglet | *Regulus satrapa* | C | | | | | | |
| Water pipit | *Anthus spinoletta* | | | | O | O | | O |
| Cedar waxwing | *Bombycilla cedrorum* | | O | O | O | | | |
| Hutton's vireo | *Vireo huttoni* | | O | O | | | | |
| Warbling vireo | *Vireo gilvus* | | C | C | | | | |
| Orange-crowned warbler | *Vermivora celata* | | C | | | | | |
| Yellow warbler | *Dendroica petechia* | | C | O | | | O | |
| Myrtle warbler | *Dendroica coronata* | | O | C | | | | |
| Audobon's warbler | *Dendroica audonboni* | C | O | C | | | | |
| Black-throated gray warbler | *Dendroica nigrescens* | C | | | | | | |
| Townsend's warbler | *Dendroica townsendi* | C | | | | | | |
| MacGillivray's warbler | *Oporornis tolmiei* | | O | C | | | | |
| Wilson's warbler | *Wilsonia pusilla* | C | O | O | | | O | |
| House sparrow | *Passer domesticus* | | | | O | | C | |
| Western meadowlark | *Sturnella neglecta* | | | | C | | | |
| Red-winged blackbird | *Agelaius phoeniceus* | | | | O | C | | |

## COMMON BIRDS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA (CONT'D)

| | | Biotic communities | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Common name | Scientific name | Coniferous Forest 1 | Broadleaf Forest 2 | Riparian/Lakes 3 | Pasture-Meadow 4 | Marsh/Brackish 5 | Residential 6 | Marine Shoreline 7 |
| Land-associated birds (cont'd) | | | | | | | | |
| Brewer's blackbird | *Euphagus cyanocephalus* | | | | C | | O | |
| Bullock's oriole | *Icterus bullockii* | | C | O | O | O | | |
| Western tanager | *Piranga ludoviciana* | C | C | C | | | | |
| Evening grosbeak | *Hesperiphona vespertina* | C | O | O | | | O | |
| Pine grosbeak | *Pinicola enucleator* | C | O | O | | | O | |
| Purple finch | *Carpodacus purpureus* | O | C | O | | | | |
| House finch | *Carpodacus mexicanus* | | | | | | C | |
| Pine siskin | *Spinus pinus* | C | | | | | | |
| American goldfinch | *Spinus tristis* | | C | O | O | | | |
| Red crossbill | *Loxia curvirostra* | O | O | | | | | |
| Rufous-sided towhee | *Pipilio erythrophthalmus* | O | O | O | | | | |
| Slate-colored junco | *Junco hyemalis* | | O | | | | | |
| Oregon junco | *Junco oreganus* | O | C | O | O | | | |
| Savannah sparrow | *Passerculus sandwichensis* | | | | O | C | | O |
| White-crowned sparrow | *Zonotrichia leucophrys* | | | C | O | C | | O |
| Golden-crowned sparrow | *Zonotrichia atricapilla* | | O | O | O | | | |
| Song sparrow | *Melospiza melodia* | | | C | O | C | O | O |

[a] key to occurrence

C = common or seasonal resident

O = occasional

## Appendix B-4

## MAMMALS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA

| Common name | Scientific name | Biotic communities<br>1 Coniferous Forest | 2 Broadleaf Forest | 3 Mixed/Riparian | 4 Pasture Meadow | 5 Freshwater Marsh | 6 Residential | 7 Marine Shoreline |
|---|---|---|---|---|---|---|---|---|
| Dusky shrew | *Sorex obscurus* |  |  | x |  | x |  |  |
| Vagrant shrew | *Sorex vagrans* |  |  | x |  | x |  |  |
| Water shrew | *Sorex palustris* |  |  | x |  | x |  |  |
| Marsh shrew | *Sorex bendirii* |  |  | x |  | x |  |  |
| Masked shrew | *Sorex cinereus* |  | x | x |  | x |  |  |
| Trowbridge shrew | *Sorex trowbridgii* | x |  | x |  |  |  |  |
| Townsend mole | *Scapanus townsendii* |  |  |  | x |  | x |  |
| Coast mole | *Scapanus orarius* |  | x |  | x |  |  |  |
| Shrew-mole | *Neorotrichus gibbsii* |  |  | x |  |  |  |  |
| Little brown myotis | *Myotis lucifugus* |  |  | x |  |  |  |  |
| Keen myotis | *Myotis keenii* |  | x | x |  |  |  |  |
| California myotis | *Myotis californicus* | x | x | x |  |  |  |  |
| Hairy-winged myotis | *Myotis volans* | x | x | x |  |  |  |  |
| Long-eared myotis | *Myotis evotis* | x | x | x |  |  |  |  |
| Yuma myotis | *Myotis yumanensis* |  | x | x |  |  |  |  |
| Silvery-haired bat | *Lasionylteris noctivagans* |  | x | x |  |  |  |  |
| Big brown bat | *Eptesicus fuscus* |  | x |  |  |  |  |  |
| Hoary bat | *Lasiurus cinereus* |  | x |  |  |  |  |  |
| Lump nosed bat | *Plecotus townsendii* |  | x |  |  |  |  |  |
| Snowshoe hare | *Lepus americanus* | x | x | x |  |  |  |  |
| Eastern cottontail | *Sylvilagus floridanus* |  | x |  | x |  | x |  |
| Mountain beaver | *Aplodontia rufa* | x | x | x |  |  | x |  |
| Hoary marmot | *Marmota caligata* |  |  |  | x |  |  |  |
| Townsend chipmunk | *Eutamias townsendii* | x |  | x |  |  |  |  |
| Merriam chipmunk | *Eutamias merriami* |  | x | x |  |  |  |  |
| Long-eared chipmunk | *Eutamias quadrimaculatus* | x |  |  |  |  |  |  |
| Douglas squirrel | *Tamiasciurus douglasii* | x |  |  |  |  |  |  |
| Western gray squirrel | *Sciurus griseus* |  | x | x |  |  |  |  |
| Northern flying squirrel | *Glaucomys sabrinus* | x |  |  |  |  |  |  |
| Mazama pocket gopher | *Thomomys mazama* |  |  |  | x |  | x |  |
| Beaver | *Castor canadensis* |  |  | x |  | x |  |  |
| Deer mouse | *Peromyscus maniculatus* |  |  | x | x | x |  |  |

## MAMMALS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA (CONT'D)

| Common name | Scientific name | Biotic communities | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Coniferous Forest 1 | Broadleaf Forest 2 | Mixed/Riparian 3 | Pasture Meadow 4 | Freshwater Marsh 5 | Residential 6 | Marine Shoreline 7 |
| Bushy-tailed wood rat | *Neotoma cinerea* | | x | x | | | | |
| Northern bog vole | *Synaptomys borealis* | | | | x | x | | |
| Gapper red-backed mouse | *Clethrionomys gapperi* | | | | x | | | |
| Long-tailed meadow mouse | *Microtus longicaudus* | | | x | x | | | |
| Oregon meadow mouse | *Microtus oregoni* | | | | x | x | | |
| Townsend meadow mouse | *Microtus townsendii* | | | | x | | | |
| Muskrat | *Ondatra zibetnica* | | | x | | x | | |
| Pacific jumping mouse | *Zapus trinotatus* | | | | x | | | |
| Coyote | *Canis latrans* | x | x | x | x | x | | |
| Black bear | *Euarctos americanus* | x | x | x | | | | |
| Racoon | *Procyon lotor* | x | x | x | x | x | x | |
| Ermine | *Mustela erminea* | x | | | | | | |
| Long-tailed weasel | *Mustela fernata* | | x | x | x | | | |
| Fisher | *Martes pennanti* | x | | | | | | |
| Mink | *Mustela vison* | | | x | | x | | |
| Marten | *Martes americana* | x | x | x | | | | |
| Striped skunk | *Mephitis mephitis* | x | x | x | x | | | |
| Spotted skunk | *Spilogale putorius* | x | x | x | x | | | |
| River otter | *Lutra canadensis* | | | x | | | | |
| Sea otter | *Enydra lutris* | | | | | | | x |
| Mountain lion | *Felis concolor* | x | x | x | | | | |
| Bobcat | *Lynx rufus* | x | x | x | x | | | |
| Harbor seal | *Phoca vitulina* | | | | | | | x |
| Black-tailed deer | *Odocoileus hemionus columbianus* | x | x | x | x | | x | |
| Canadian elk | *Cervus canadensis nelsoni* | x | x | x | x | | | |

## Appendix B-5

## AMPHIBIANS AND THEIR PROBABLE OCCURRENCE WITHIN STUDY AREA

| | | Biotic communities | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **Coniferous Forest 1** | **Broadleaf Forest 2** | **Mixed/Riparian 3** | **Pasture-Meadow 4** | **Freshwater Marsh 5** | **Residential 6** | **Marine Shoreline 7** |
| Western long-toed salamander | *Ambystoma macrodactylum macrodactylum* | x | x | x | | | | |
| Northwestern salamander | *Ambystoma gracile gracile* | x | x | x | | | | |
| Northern Olympic salamander | *Rhyacotriton olympicus olympicus* | x | x | x | | | | |
| Pacific giant salamander | *Dicamptodon ensatus* | x | x | x | | | | |
| Western red-backed salamander | *Plethodon vehiculum* | x | x | x | | | | |
| Van Dyke's salamander | *Plethodon vandykei vandykei* | x | x | x | | | | |
| Rough-skinned newt | *Taricha granulosa* | x | x | x | x | | | |
| Pacific treefrog | *Hyla regilla* | | x | x | | x | | |
| Bullfrog | *Rana catesbelana* | | | x | | x | | |
| Tailed frog | *Ascaphus truei* | x | | x | | x | | |
| Northern red-legged frog | *Rana aurora aurora* | | | x | | x | | |
| Boreal toad | *Bufo boreas boreas* | | x | x | x | | x | |
| Western spotted frog | *Rana pretiosa pretiosa* | | x | x | | x | | |
| Northern alligator lizard | *Gerrhonotus coeruleus principis* | x | x | x | | | | |
| Northwestern garter snake | *Thamnophis ordinoides ordinoides* | x | x | x | x | x | x | |
| Puget Sound red-sided garter snake | *Thamnophis sirtalis pickeringi* | x | x | x | x | x | x | |
| Pacific rubber boa | *Charina bottae bottae* | x | x | x | x | | | |

# APPENDIX C

## MODELING OF WASTE DISPOSAL SITES

To relate effluent quality and the water quality standards, it is necessary to consider the mechanisms that affect marine wastewater disposal. Discharged wastewater, being less dense than the surrounding ocean water, ascends from the point of discharge in the form of an expanding plume. As the wastewater rises, it mixes with the adjacent ocean water until the density of the wastewater-ocean water mixture becomes equal to the density of the surrounding ocean water.

Dilution effected during this process is called initial dilution and results from the mixing induced by the dissipation of energy as the initial and buoyant momentums of the discharged wastewater are exhausted. The degree of initial dilution depends on the diffuser design, the height of the rising plume, and the rate of transport of diluted wastewater away from the area above the diffuser. The rising plume may stabilize at or below the ocean surface, depending on the discharge depth and the prevailing density structure of the ocean. As the wastewater-seawater field moves away from the discharge point, it is subject to further dilution due to horizontal dispersion. Concentrations of nonconservative waste constituents are still further reduced by decay or disappearance.

Because the purpose of the diffuser system is to induce rapid mixing of effluent with seawater in order to minimize the possibility of contact between marine organisms and high concentrations of wastewater, it is apparent that the initial dilution is the most important of the diminution processes. Effective initial dilution depends on two phenomena: rapid momentum-induced mixing of wastewaters with seawater, and transport of clean dilution water across the site. The former phenomenon can be controlled by the system designer, provided an adequate depth of water exists, while the latter is an uncontrollable natural characteristic of the discharge site. In general, it is the latter phenomenon that controls the degree of initial dilution obtainable at a specific site.

Once initial dilution is completed, further waste concentration dimunition depends on horizontal dispersion and decay mechanisms. For waste constituents that do not decay rapidly, the degree of flushing or residence time of waters within the boundaries of the receiving area determines the steady-state concentrations of waste constituents that will remain.

Thus it becomes apparent that with respect to both initial dilution and horizontal dispersion a key issue in comparing candidate sites is the degree of mixing that occurs at each site. Another key issue--the relative sensitivity of the biological community in the discharge area--is considered elsewhere in this report.

In the course of facilities planning activities, two models were used to study water quality and mixing within the study area: mathematical ecologic model applied by EPA to a part of Puget Sound, and the University of Washington's physical model of Puget Sound. Each of the models is described briefly below, together with a discussion of its limitations.

## The Ecologic Model

A mathematical model was used to simulate and link together ecologic succession from primary producers through successively higher levels in the marine environment. The ecologic model was combined with a hydrodynamic model in order to predict water quality and biological characteristics that might occur as a result of waste discharge.

Due to limitations in the data base for verification and the fact that the relationships between different trophic levels are only poorly understood, the model is of limited use in simulating the effects of waste discharge upon water quality and biological characteristics in Puget Sound at the present time. To quote the modeling report "The ecologic model.....can only be considered as a preliminary tool for evaluating water quality effects of waste discharge upon Port Orchard. The simulations.....should be evaluated principally in terms of relative effects." For these reasons it is concluded that the ecologic model is of little or no value in comparing outfall sites for the Sinclair Inlet planning area.

## The Physical Model

The second model used in the study was the University of Washington hydraulic model. The final report on the hydraulic model studies of the possible outfall locations within the Port Orchard System and its connecting passageways and inlets was submitted to the URS Company in November 1975. Some measurements of water movements in the field were made with vessel-mounted current meters and drogues in order to verify the model results.

The study area for the physical hyrdaulic model encompasses an area about 12 miles wide, from the edge of Dyes Inlet eastward to Point

Jefferson, and about 16 miles long, from Sinclair Inlet eastward to Point Jefferson and beyond. Given the horizontal scale ratio for the Puget Sound model, this area represents a rectangular grid 19 inches wide by approximately 25 inches long. Hydraulic modeling of such a physically small area can give erroneous results if extensive care is not taken to assure precise measurement of all controllable parameters. Vertical and horizontal scale ratios were adjusted to reduce possible side effects of surface tension and laminar flow, thus producing better results. In general, model results can be regarded as accurate, but there are limitations to this model which raise questions regarding the ability of the model to simulate water circulation in relatively shallow waters such as the lower part of Sinclair Inlet.

There are three major limitations of this model which cannot be avoided. Because of the effects of surface tension and land topography it was not possible to incorporate the effects of wind into the modeling of the study area. Winds and the waves caused by winds contribute significantly to mixing. Surface drag between wind and water interfaces can modify tides, surface transport of the effluent and water exchange processes.

Surface tension is also an important factor in the scaling of any large body of water with a relatively shallow depth. Its effects strongly influence water movement in shoals or near the shoreline, especially in areas where current velocities are low enough that the water in the basin remains relatively undisturbed. As a result of surface tension, estimations of current velocities are unreliable where real tidal currents are weak.

Viscosity is another factor that cannot be scaled; thus, the possibility of laminar flow in the model exists where turbulent flow actually occurs in the area under consideration. This limitation, like that relating to current velocity, is due to scale effects of the model.

# APPENDIX D

## BIOLOGICAL MARINE ENVIRONMENT

## D-1 BIOTIC COMMUNITIES

The Marine ecosystem within the waterways, inlets and passages of Puget Sound is a complex system with myriad links and multiple affecting factors. The Kitsap County marine environment has been described in detail in *Basic Data and Related Sources to Shorelines* by the Kitsap County Planning Department. The inventory was compiled from marine biological records of the Bureau of Sports Fisheries and Wildlife, Department of Interior in conjunction with Evergreen State College and the North Kitsap Marine Environmental Center, Poulsbo, Washington. Portions of this report are quoted extensively below.

### Marine Vegetation

> *Vegetation in saltwater and estuarine areas of Puget Sound and connected waterways is very important to the marine environment. Marine vegetation can provide the following benefits: stabilization of the beach shore system and the subtidal shore system; an environment for wildlife, benthic and other marine life; energy through the photosynthesis process; increased productivity in the marine environment; food for all forms of marine life. Examples of marine vegetation are kelp, eel grass (Zostera), green and brown algae--commonly known as seaweed--and other forms of floating plants.*

Eel grass and kelp are important dominants and are discussed below.

### Eel Grass

> *Eel grass can be found in areas with high water salinities, moderate water currents and semistable sandy bottoms, and usually at depths lower than one foot below mean lower low water. Eel grass is a cyclical* [seasonal] *plant that thrives in warm water temperatures ...* [from 10°-20°C during the summer, being dormant in cooler fall and winter water temperatures, below 10°C]. *Eel grass is a food source for black brant, detritous feeders such as limpets and snails, and other marine life.*

*The heavy beds of underwater eel grass provide ...* [excellent] *photosynthetic food production capability. They are used by spawning herring and provide nursery areas for small shore fishes and salmonids. The eel grass beds also provide habitat for certain benthic organisms and crustaceans.*

### Kelp

*Kelp beds can be readily seen at low tides along rocky shorelines where current flow is swift and water salinities are high. A long, whip-like cord, anchored at one end to a rock or other object, ...* [extends upward 30 to 60 feet toward the surface to a mass of long, tough fronds]. *Kelp beds provide a dense, jungle-like environment at mid-depth in the water column, like large underwater trees. Kelp beds are prime habitat areas for fish such as copper rock cod; kelp cod, kelp crab, perches and other small fish.*

## Marine Habitat

The marine shorelines of the study area can be grouped into three habitat zones. This classification provides a basic understanding of the general character of shorelines and the associated marine life.

### River-Creek Mouth

*The river-creek mouth may either be an open system* [e.g., Chico Creek on lower Dyes Inlet] *or be enclosed by a system of sand spits ...* [or one that has resulted from human intervention (Clear Creek on upper Dyes Inlet)]. *Sand and silt usually comprise the bottom materials. For anadromous fish (salmonids) spawning in tributaries to these areas, the salt/fresh water area is used by descending young salmonids for feeding, as a transition zone between fresh and saltwater, and as a refuge from predators. The substrate in these areas provides and harbors organisms that are extensively grazed upon by juvenile pink and chum salmon. Other fish make extensive use of these areas for feeding and as a nursery area. Such fish include starry flounder, stickleback, eulachon, surf perch, sculpin, Pacific herring, surf smelt and various species of flounder and sole. Some fish may spawn in these areas. At depths greater than one foot below mean lower low water, eel grass may be present.* [Pacific herring and surf perch may spawn here.]

> *Dungeness crab (particularly jeveniles) feed extensively in this type of habitat during the summer and fall months. Shrimp usually inhabit the bottom substrate. If bottom conditions are favorable, clams may be found in the sediment.*

Steelhead salmon and cutthroat trout have been observed in the lagoon at the mouth of Clear Creek.

Wildfowl, particularly heron, are attracted to estuarine environments and sandy beaches. Herons are common in these areas, yet the Pacific Flyway population is small. Shorebirds feed on the numerous snails, worms and insects of the estuaries and shorelands. Some species also nest in the near vicinity, under the protection of cover and trees. The river-creek mouth areas are also important for food and shelter to all wildfowl during climatic stress conditions such as prolonged cold periods, strong winds and severe storms. Marsh grasses usually border the shoreline areas of estuaries. Nutrients produced by these plants feed the food chain mechanisms and associated plant and animal cummunities in other types of habitat adjacent to river and creek mouths.

### Open-Mud Bays

> *Open-mud bays without fresh water source (e.g., lower portions of Dyes Inlet and Liberty Bay) are characterized by an extensive intertidal zone, large mud flat areas and marsh grasses around the periphery. Sand and silt usually make up the bottom materials. Lack of fresh water ...* [limits] *use of these areas by juvenile salmonids as a transition zone between fresh and saltwater; however, they still provide rich feeding areas for juvenile salmonids. Shallow water provided by this type of habitat also provides refuge for young salmon from larger predatory fish. Other fish make extensive use of these areas for feeding and as a nursery area. Such fish include starry flounder, stickleback, eulachon, surf perch, sculpin, Pacific herring and various species of flounder and sole. At depths greater than one foot below mean lower low water, eel grass may occur, ...* [providing spawning conditions for Pacific herring and surf perch]. *Dungeness crab, oysters and oyster drills are found in Chico Bay.*

Salmon and cutthroat trout are found along the entire shoreline of Dyes Inlet. Smelt historically have spawned on the shoreline from Chico Bay to Silverdale. Littleneck and butter clams may be found at the head of Dyes Inlet, while bent-nose clams and other clams, shore crabs, barnacles, snails, tube worms and sand dollars are found in the general area.

> *Nutrients produced by the marsh grasses and algal communities of this habitat serve to sustain food chain mechanisms and associated communities in other types of habitat adjacent to these areas.*

## *Sand-Gravel-Cobble Beach*

*Sand-gravel-cobble beach are typical of most shorelines in Kitsap County. Most of the beaches in Puget Sound fall into this category. Marsh grass is usually not present or is found in very limited distribution in association with this type of habitat. Rockweed and sea lettuce are the types of vegetation usually found in the middle of low tide zones. Eel grass might be present at depths greater than one foot below mean lower low water. At about this depth, the bottom will usually be of a sandy type, with less rock ...* [except at protruding points of land]. *Anadromous fish utilize these shorelines as migrating areas, for feeding and as protection from predators. Cutthroat trout, salmon and rockfish can be found along the shoreline. Benthic examination off Point Herron revealed periwinkles, limpets, shore crabs and barnacles. Herring also spawn off Point Herron. Subtidal geoduck are found from Ilahee to University Point. At Ilahee, butter, littleneck and bent-nose clam, barnacle, shore and butter crab, tube worm, mussel and periwinkle have been found.*

Wildfowl also utilize this type of habitat. Use is usually dependent on the presence of some type of vegetation on the bottom interface, fish concentrations or presence of aquatic vegetation in areas where fresh water crosses the beach. Bars, spits and gravel beaches are favored by wintering black brant, which travel in great numbers along the Pacific Flyway.

## Vertical Zones

Plant and animal life within the marine environment normally exhibit a vertical stratification representing three ecological niches. They are the benthic, water column and surface zones, which are distinct and yet interact with each other. The benthic zone includes the bottom sediments and the associated immediately overlying areas. The water column zone is that portion of the marine environment where the water column meets the benthic zone to two feet under the water surface. The surface zone is that portion of the water environment above the water column zone to six feet above the surface of the water body.

## The Benthic Zone

The benthic community essentially covers all bottom-dwelling plants and animals. These include infauna living within the substrate, such as clams and worms, and epifauna utilizing the zone above the substrate, such as crabs, barnacles, mussels, limpets and snails.

> *Man places a direct value on some of the benthic organisms, such as clams, oysters, other edible molluscs and crustaceans. Others, while not seeming to be of value, are actually of great indirect importance through various food-chain and food-web relationships. Barnacles, which are abundant in the intertidal zone are often considered a nuisance, at worst, and of no importance at best. They are actually an important source of food for several species, including the pile perch. The bent nose clam, while it seldom attains a size large enough for people to feast on, is the victim of an interesting feeding relationship in which the English sole bites off the siphon of the clam if the fish finds it sticking up from the sand. Both the perch and the sole are food for man.*
>
> *Other seemingly unimportant benthic organisms, such as isopods, amphipods, polychaete and nemertean worms, should not be overlooked, as they too are part of intricate food-web relationships that may involve man.*
>
> *Many of the worms and crustaceans play an important role in the ecology of the benthic community by acting as scavengers, eating dead plants and animals on the bottom and helping to convert them back to nutrients for the algae.*

The numbers and types of benthic organisms that inhabit a particular area are dependent upon factors such as degree of slope, substrate composition, tide level, wave action and influences of man.

Within the planning area, baseline benthic data for Puget Sound are currently being collected at Shoreline Community College. Limited data on sampling stations in Dyes Inlet, Sinclair Inlet, Port Orchard, Rich Passage and Puget Sound near Bainbridge Island have been extracted from studies by J.C. Serwold (Reference 1). Benthic sampling locations are shown on Figure II-11. Preliminary benthic data for selected locations are given in Table II-16.

In the shallow portions of Dyes Inlet--less than 20 feet deep--are found Washington clam (*Saxidomonas gigantus*), manila clam (*Venerupis japonica*), cockles (*Clinocardium nuttalli*), lean dog whelk (*Nassarius mendicus*) and over 15 species of polychaete worms, of which the lumberinerids, ampharetids, orbiniids and trichobranchids are most common.

In the lower end of Sinclair Inlet--less than 30 feet deep--are Washington clam, the small clams *Axinopsis serricatus* and *Psephidia lordi*, lumberinerid and cirratulid polychaetes and some unidentified cumaceans.

At the mouth of Rich Passage offshore of Manchester, in water depths greater than 60 feet, were found large concentrations of the small clam *Axinopsis serricatus* and some *Macoma carlottensis*. Polychaetes were generally scarce.

Benthic fishes in the general study area include spiny dogfish; bay goby; great, rough-back and Pacific sculpins; speckled sanddab; starry flounder; and flathead, rock, slender, English, C-O and sand sole. A more complete listing of probably occurring fish species is given in Appendix D.

## The Water Column Zone

Marine life in the water column zone is extremely complex and difficult to comprehend completely. It has been observed that many animals, including salmonids, rockfish, bottom fish, herring, oysters and shrimp, utilize the water body. These life forms each have a life cycle in which from birth to maturity there are strict requirements or limits within their migratory or territorial ranges for survival.

> *The intertidal and the subtidal zones, where the process of photosynthesis is carried on, is important to the existence of these fish. The intertidal zone is visited by many fish, especially at nighttime, to feed on the collected waste, decomposed plant life, smaller shore life and other smaller fishes on the bottom. During the daytime, the larger fish retreat to safe deeper waters. Shallow bay and shoreline areas are necessary during the infant state of development for many fishes.*

Important local fish species in the water column include stickleback, eulachon, bay pipefish, pricklebacks, shiner and pile perch, striped and white seaperch, sturgeon and pygmy poacher. Fishes favoring algal and other vegetative associations include northern clingfish, plainfin midshipman, blackbelly eelpout, whitespotted greenling and longspine combfish. Other pelagic fishes include Pacific herring, salmon, Pacific cod, Pacific hake, walleye pollock and Pacific tomcod. A more complete list of probably occurring fish species is given in Appendix D.

## The Surface Zone

> *The surface zone is used for navigation, water contact sports and visual and aesthetic appreciation; as a resting area for wildfowl; and for protection of small fish, predation by larger fish and swimming by mammals such as seals and otters.* [This zone is utilized by all life forms, including—indirectly—benthic life in the intertidal zone.] *Phytoplankton require high percentages of light transmission to carry on the photosynthesis process.*

Increased water turbidity or any activity which occupies the total surface zone hinders any other use of that zone and halts phytoplankton production. Since the surface zone consists of an interface of water element and air element, it is important to consider this zone as an *edge* environment which is affected by activity or development on either side.

Algal concentration studies for Sinclair and Dyes Inlet were performed in *Ecologic Modeling of Puget Sound and Adjacent Waters* (Reference 23). Although limited phytoplankton data were available for the calibration, the algal concentrations were studied for their value as an indicator of productivity in the marine environment and as an indicator of other factors, such as nutrients, light, certain growth coefficients and zooplankton. Computed algal biomass concentrations in Dyes and Sinclair Inlets are shown in Figure II-12. A species nonspecific algal biomass was computed, based on 80 mg biomass corresponding to one mg chlorophyll a.

In winter, the model computed the lowest algal biomass with an average of 800 μg/l in Port Orchard. Spring values were higher, presumably due to increased light (heat) energy and upstream nutrient inputs. Concentrations exceeding 1,500 μg/l were computed for Sinclair Inlet, Port Washington Narrows, Dyes Inlet and Liberty Bay. Model results show that summer algal concentrations dropped to approximately 500 μg/l in the bays and inlets while remaining relatively high in Port Washington Narrows and near Bremerton. By contrast, the main channel of Puget Sound, near Bainbridge Island, ranges from 5 μg/l in the winter to 348 μg/l in the spring. Model results can only approximate true conditions, which could vary from those predicted.

The seasonal pattern of variation in algal concentration tends to infer that phytoplankton in Puget Sound are primarily limited by light and secondarily by the input of nutrients. Continuously high concentrations from spring to summer in Port Washington Narrows reflects the nutrient loading from the Mannette Sewage Treatment Plant wastewater outfall on the western shore of East Bremerton and the return of much of that wastewater at each tidal cycle.

## Appendix D-2

## PROBABLE FISH SPECIES AND ABUNDANCE WITHIN THE STUDY AREA

| Common Name | Scientific Name | Central Puget Sound | Port Orchard | Seattle |
|---|---|---|---|---|
| River lamprey | *Lampetra ayresi* | + |  | + |
| Sixgill shark | *Hexanchus griseus* | + |  | + |
| Basking shark | *Cetorhinus maximus* |  |  | + |
| Salmon shark | *Lamna ditropis* | + |  | + |
| Brown cat shark | *Apristurus brunneus* | * |  | * |
| Pacific sleeper shark | *Somniosus pacificus* |  |  | + |
| Spiny dogfish | *Squalus acanthias* | 0 | 0 | 0 |
| Pacific angel shark | *Squatina californica* |  |  | + |
| Pacific electric ray | *Torpedo californica* | + | + |  |
| Big skate | *Raja binoculata* | + | * | + |
| Longnose skate | *Raja rhina* | * | * | * |
| Ratfish | *Hydrclagus colliei* | 0 | * | 0 |
| White sturgeon | *Acipenser transmontanus* |  | + | + |
| American shad | *Alosa sapidissima* | + | + | * |
| Pacific herring | *Clupea harengus pallasi* | 0 | 0 | 0 |
| Pacific sardine | *Sardinops sagax* |  | + |  |
| Northern anchovy | *Engraulis mordax* | + | * | + |
| Pink salmon | *Oncorhynchus gorbuscha* | 0 | * | 0 |
| Chum salmon | *Oncorhynchus keta* | 0 | + | 0 |
| Coho salmon | *Oncorhynchus kisutch* | 0 | + | 0 |
| Sockeye salmon | *Oncorhynchus nerka* | 0 | + | 0 |
| Chinook salmon | *Oncorhynchus tshawytseha* | 0 | 0 | 0 |
| Cutthroat trout | *Salmo clarki* | + | * | * |
| Rainbow trout | *Salmo gairdneri* | + |  | + |
| Dolly Varden | *Salvelinus malma* | + |  | * |
| Surf smelt | *Hypomesus pretiosus* | * | 0 | 0 |
| Longfin smelt | *Spirinchus thaleichthys* | * | + | * |
| Eulachon | *Thaleichthys pacificus* | + |  | + |
| Longnose lancetfish | *Alepisaurus ferox* | + |  |  |
| California headlightfish | *Diaphus theta* | + |  |  |
| Northern lampfish | *Stenobrachius leucopsarus* | + |  |  |
| Plainfin midshipman | *Porichthys natatus* | 0 | 0 | 0 |
| Northern clingfish | *Gobiesox maeandricus* |  | * | + |
| Pacific cod | *Gadus macrocephalus* | 0 | 0 | 0 |
| Pacific hake | *Merluccius productus* | 0 | 0 | 0 |
| Pacific tomcod | *Microgadus proximus* | 0 | 0 | 0 |
| Walleye pollock | *Theragra chalcogramma* | 0 | 0 | 0 |
| Red brotula | *Brosmophycis marginata* | * | + | * |
| Pallid eelpout | *Lycodapus mandibularis* | * |  | * |
| Shortfin eelpout | *Lycodes brevipes* | + | + | + |
| Black eelpout | *Lycodes diapterus* | * | + | * |
| Wattled eelpout | *Lycodes palearis* | * |  | + |
| Blackbelly eelpout | *Lycodopsis pacifica* | 0 | 0 | 0 |
| Tube-snout | *Aulorhynchus flavidus* | * | * | 0 |
| Threespine stickleback | *Gasterosteus aculeatus* | * | * | * |
| Bay pipefish | *Syngnathus griseolineatus* | * | 0 | 0 |
| Shiner perch | *Cymatogaster aggregata* | 0 | 0 | 0 |
| Striped seaperch | *Embiotoca lateralis* | 0 | 0 | 0 |
| White seaperch | *Phanerodon furcatus* |  | + | + |
| Pile perch | *Rhacochilus vacca* | 0 | 0 | 0 |

# PROBABLE FISH SPECIES AND ABUNDANCE WITHIN THE STUDY AREA (CONT'D)

| Common Name | Scientific Name | Central Puget Sound | Port Orchard | Seattle |
|---|---|---|---|---|
| Pacific barracuda | *Sphyraena argentea* | + |  | + |
| Northern ronquil | *Ronquilus jordani* | * | * | 0 |
| High cockscomb | *Anoplarchus purpurescens* | + |  | + |
| Mosshead warbonnet | *Chirolophis nugator* | + |  | + |
| Decorated warbonnet | *Chirolophis polyactocephalus* | + |  |  |
| Daubed shanny | *Lumpenus maculatus* | + |  | + |
| Snake prickleback | *Lumpenus sagitta* | * | 0 | 0 |
| Ribbon prickleback | *Phytichthys chirus* | + |  |  |
| Bluebarred prickleback | *Plectobranchus evides* | * |  | * |
| Whitebarred prickleback | *Poroclinus rothrocki* | + | + | + |
| Black prickleback | *Xiphister atropurpureus* |  |  | + |
| Penpoint gunnel | *Apodichthys flavidus* | * | + | 0 |
| Crescent gunnel | *Pholis laeta* | * | + | * |
| Saddleback gunnel | *Pholis ornata* | + | + | * |
| Rockweed gunnel | *Xererpes fucorum* |  |  | + |
| Wolf-eel | *Anarrhichthys ocellatus* | + |  | + |
| Quillfish | *Ptilichthys goodei* |  |  | + |
| Giant wrymouth | *Delolepis gigantea* |  | + | + |
| Dwarf wrymouth | *Lyconectes aleutensis* | + |  |  |
| Pacific sand lance | *Ammodytes hexapterus* | * | + | 0 |
| Arrow goby | *Clevelandia ios* | + |  | + |
| Blackeye goby | *Coryphopterus nicholsi* | + | + | * |
| Bay goby | *Lepidogobius lepidus* | * | 0 | + |
| Pacific bonito | *Sarda chiliensis* | + |  | + |
| Pacific pompano | *Peprilus simillimus* |  | * | + |
| Ragfish | *Icosteus aenigmaticus* |  |  |  |
| Brown rockfish | *Sebastes auriculatus* | + | * | + |
| Copper rockfish | *Sebastes caurinus* | 0 | * | 0 |
| Darkblotched rockfish | *Sebastes crameri* |  |  | + |
| Splitnose rockfish | *Sebastes diploproa* | + |  |  |
| Greenstriped rockfish | *Sebastes elongatus* | + |  | + |
| Puget Sound rockfish | *Sebastes emphaeus* |  |  | + |
| Yellowtail rockfish | *Sebastes flavidus* |  |  | + |
| Quillback rockfish | *Sebastes maliger* | * | + | * |
| Black rockfish | *Sebastes melanops* | * | + | * |
| Tiger rockfish | *Sebastes nigrocinctus* | + |  | + |
| Bocaccio | *Sebastes paucispinis* | + | + | + |
| Canary rockfish | *Sebastes pinniger* |  |  | + |
| Redstripe rockfish | *Sebastes proriger* | + |  | + |
| Yelloweye rockfish | *Sebastes ruberrimus* |  |  | + |
| Stripetail rockfish | *Sebastes saxicola* |  |  | + |
| Sharpchin rockfish | *Sebastes zacentrus* |  |  | + |
| Shortspine thornyhead | *Sebastolobus alascanus* | + |  |  |
| Sablefish | *Anoplopoma fimbria* | 0 | * | + |
| Kelp greenling | *Hexagrammos decagrammus* | * | + | * |
| Rock greenling | *Hexagrammos lagocephalus* | + | + | + |
| Whitespotted greenling | *Hexagrammos stelleri* | * | 0 | * |
| Lingcod | *Ophiodon elongatus* | 0 | * | * |
| Painted greenling | *Oxylebius pictus* | + | + | 0 |
| Longspine combfish | *zaniolepis latipinnis* | + | 0 | + |

## PROBABLE FISH SPECIES AND ABUNDANCE WITHIN THE STUDY AREA (CONT'D)

| Common Name | Scientific Name | Central Puget Sound | Port Orchard | Seattle |
|---|---|---|---|---|
| Padded sculpin | *Artedius fenestralis* | * | * | 0 |
| Scalyhead sculpin | *Artedius harringtoni* | + | + | * |
| Smoothhead sculpin | *Artedius lateralis* | + | + | 0 |
| Puget Sound sculpin | *Artedius meanyi* | + | | |
| Rosylip sculpin | *Ascelichthys rhodorus* | + | | + |
| Silverspotted sculpin | *Blepsias cirrhosus* | + | + | * |
| Roughback sculpin | *Chitonotus pugetensis* | 0 | 0 | 0 |
| Sharpnose sculpin | *Clinocottus acuticeps* | + | | * |
| Calico sculpin | *Clinocottus embryum* | + | | |
| Mosshead sculpin | *Clinocottus globiceps* | | + | + |
| Spinyhead sculpin | *Dasycottus setiger* | + | | + |
| Buffalo sculpin | *Enophrys bison* | * | + | 0 |
| Soft sculpin | *Gilbertidia sigalutes* | + | + | + |
| Red Irish lord | *Hemilepidotus hemilepidotus* | + | | * |
| Northern sculpin | *Icelinus borealis* | + | | * |
| Threadfin sculpin | *Icelinus filamentosus* | + | | * |
| Spotfin sculpin | *Icelinus tenuis* | + | + | 0 |
| Longfin sculpin | *Jordania zonope* | + | | |
| Pacific staghorn sculpin | *Leptocottus armatus* | 0 | 0 | 0 |
| Great sculpin | *Myoxocephalus polyacanthocephalus* | * | 0 | * |
| Sailfin sculpin | *Nautichthys oculofasciatus* | * | * | 0 |
| Tidepool sculpin | *Oligocottus maculosus* | + | | * |
| Saddleback sculpin | *Oligocottus rimensis* | | | + |
| Tadpole sculpin | *Psychrolutes paradoxus* | * | | * |
| Slim sculpin | *Radulinus asprellus* | * | * | 0 |
| Grunt sculpin | *Rhamphocottus richardsoni* | + | + | * |
| Cabezon | *Scorpaenichthys marmoratus* | * | 0 | * |
| Manacled sculpin | *Synchirus gilli* | | | + |
| Roughspine sculpin | *Triglops macellus* | + | + | + |
| Ribbed sculpin | *Triglops pingeli* | + | + | + |
| Northern spearnose poacher | *Agonopsis emmelane* | + | + | * |
| Sturgeon poacher | *Agonus acipenserinus* | * | 0 | 0 |
| Smooth alligatorfish | *Anoplagonus inermis* | | | + |
| Gray starsnout | *Asterotheca alascana* | + | + | + |
| Spinycheek starsnout | *Asterotheca infraspinata* | + | | + |
| Bigeye poacher | *Asterotheca pentacanthus* | + | | + |
| Blackfin poacher | *Bathyagonus nigripinnis* | + | | |
| Pygmy poacher | *Odontopyxis trispinosa* | 0 | 0 | 0 |
| Tubenose poacher | *Pallasina barbata* | | + | + |
| Blacktip poacher | *Xeneretmus latifrons* | * | * | 0 |
| Bluespotted poacher | *Xeneretmus triacanthus* | + | + | * |
| Ribbon snailfish | *Liparis cyclopus* | + | | + |
| Marbled snailfish | *Liparis dennyi* | + | | + |
| Tidepool snailfish | *Liparis florae* | | | + |
| Slipskin snailfish | *Liparis fucensis* | + | | * |
| Showy snailfish | *Liparis pulchellus* | + | + | + |
| Tadpole snailfish | *Nectoliparis pelagicus* | + | + | + |
| Pacific sanddab | *Citharichthys sordidus* | 0 | * | 0 |
| Speckled sanddab | *Citharichthys stigmaens* | 0 | 0 | 0 |
| Arrowtooth flounder | *Atheresthes stomias* | 0 | * | 0 |
| Petrale sole | *Eopsetta jordani* | * | + | + |
| Rex sole | *Glyptocephalus zachirus* | 0 | * | 0 |
| Flathead sole | *Hippoglossoides elassodon* | * | 0 | * |
| Pacific halibut | *Hippoglossus stenolepis* | + | | |

## PROBABLE FISH SPECIES AND ABUNDANCE WITHIN THE STUDY AREA (CONT'D)

| Common Name | Scientific Name | Central Puget Sound | Port Orchard | Seattle |
|---|---|---|---|---|
| Butter sole | *Isopsetta isolepis* | + | + | * |
| Rock sole | *Lepidopsetta bilineata* | 0 | 0 | 0 |
| Slender sole | *Lyopsetta exilis* | 0 | 0 | 0 |
| Dover sole | *Microstomus pacificus* | 0 | * | 0 |
| English sole | *Parophrys vetulus* | 0 | 0 | 0 |
| Starry flounder | *Platichthys stellatus* | * | 0 | 0 |
| C-O sole | *Pleuronichthys coenosus* | 0 | 0 | 0 |
| Sand sole | *Psettichthys melanostictus* | 0 | 0 | 0 |
| Ocean sunfish | *Mola mola* | + |  | + |

# APPENDIX E

## ARCHAEOLOGICAL, HISTORICAL AND OTHER CULTURAL RESOURCES

The archaeological, historical and other cultural resources of southern and central Kitsap County generally consist of a cultural history and the remains of original occupation by native Americans followed by European colonization and settlement and later urbanization and industrialization. For the purposes of the environmental evaluation, however, only the physical remains and potential for as yet unknown remains and sites are most important and will be the focus of the following discussion. Archaeological and historical resources were reviewed through a survey of the proposed sites for facilities, a review of known sites located in Kitsap County by the State Historical Preservation Office and reconnaissance of the general vicinity of Bremerton, Port Orchard and Manchester. A limited potential for palentological remains (fossils) has been reviewed through an evaluation of the known geological formations.

### Archaeological Resources

The central and southern portions of Kitsap County contain no archaeological sites which have been listed on the Federal Register of Historic Landmarks or sites. Several archaeological sites have been recorded with the State Historic Preservation Officer (Washington State, Department of Parks and Recreation), and these are generally isolated sites scattered along the shore of the various inlets and bays (see Figure E-1). The precise location of these sites is not generally available but may be reviewed by qualified persons either at the Kitsap County Planninng Department or at the State Historic Preservation Office. No recorded archaeological site lies within the alternative sites for treatment facilities and pumping stations or within a 100 m [300 ft] wide corridor along the alternative pipeline routes.

The alternative project sites and corridors were surveyed but no additional archaeological sites or remains were found. Absence of sites was not unexpected, since all sites and most of the corridors have been disturbed by previous excavations or filling over the natural soils. Some areas lie totally over deep artificial fill which has been placed over mudflats.

Potential for archaeological sites generally relfects the association of known sites with physiographic and hydrological features and with probably biotic resources. Even areas presently below sea level should not be disregarded as possible sites since the sea level has risen about 10 m [30 ft] over the last 7,000 years. This may be important for an alternative crossing of Sinclair Inlet which passes down to -10 m [-30 ft]. Known sites have generally been located along the shoreline where prehistoric and later historic transportation and access were best, where waterfowl, fish and shellfish were most abundant and where the warmth of sunlight would be greatest in the early morning. Abundant rainfall diminished the importance of the freshwater streams for water supplies, but the marshes of such streams attracted waterfowl and hunters. The boggy ground along many streams and scattered through the uplands reduced the movement of Indians away from the coastal areas. Areas with the highest potential for prehistoric activity and artifacts generally lie along high ground near expansive mudflats and, if possible, near the mouth of creeks which can be reached without passage through large areas of boggy ground. A two-value map of the project vicinity reflects the above factors. The areas west of the Manette treatment plant, at or near the Charleston treatment plant, at Ross Creek, at the Retsil treatment plant, at several creek mouths south of Waterman, along Little Clam Bay and near the Manchester treatment plant have moderate to high potentials for archaeological remains in the subsurface. The general shoreline area would normally have a moderate to high potential, but the extensive excavation and filling has destroyed or buried most remains and exclude any remains from possible disturbance due to project excavations.

Past disturbances of the general urban areas of Port Orchard and Bremerton and the general shoreline areas have virtually destroyed all surface indications of possible archaeological sites or remains in these areas. Placement of large fills for existing treatment facilities, commercial development and roads have buried the natural ground under at least 3-5 m [10-15 ft] of sterile fill. Along most corridors, the alternative pipelines would lie within paved streets. At the Charleston treatment plant, existing residential structures occupy the alternative expansion area to the south, and the structures, driveways and parking pavement have eliminated all surface exposures. The alternative corridor along Hilldale Road between Waterman and Manchester has been least disturbed by construction of the existing roadway, but bedrock lies close to the ground surface and no indications of archaeological remains were observed either along the road or in the fields immediately adjacent to the roadway. In general, the severe disturbance of the surface at all alternative facility sites along the alternative pipeline routes has probably destroyed most surface archaeological remains and buried any that were below the zone of disturbance. No clear evidence exists for significant archaeological remains along the alternative project corridors.

## Historic Resources

The historic resources of the alternatives largely involve the existing structures and possible remains of earlier structures or significant remains which may have been demolished and buried under later fill or structures. The alternatives generally involve existing treatment plant sites, their immediate vicinity and the streets and roads along which the pipelines would pass. The latter corridors presently have no structures and their surfaces are typically paved. An accurate assessment could be done only at the time of the actual excavations. However, some general aspects of the corridors and the plant and pump sites will provide the basis for the effects assessment of the alternatives.

No Federally or state registered historical landmarks or sites in the vicinity of the pipeline routes have been placed on the Federal Register of Historic Landmarks: The Battleship Missouri ("Big Mo") and the Navy View Apartments of Sidney Hotel (relocated to its present site in Port Orchard). Both landmarks have been brought from other areas to their present sites as shown in Figure E-1. Consequently, the landmark sites are only significant for the structures themselves and not to the local environs. These landmarks lie more than 100 m [300 ft] from alternative facilities.

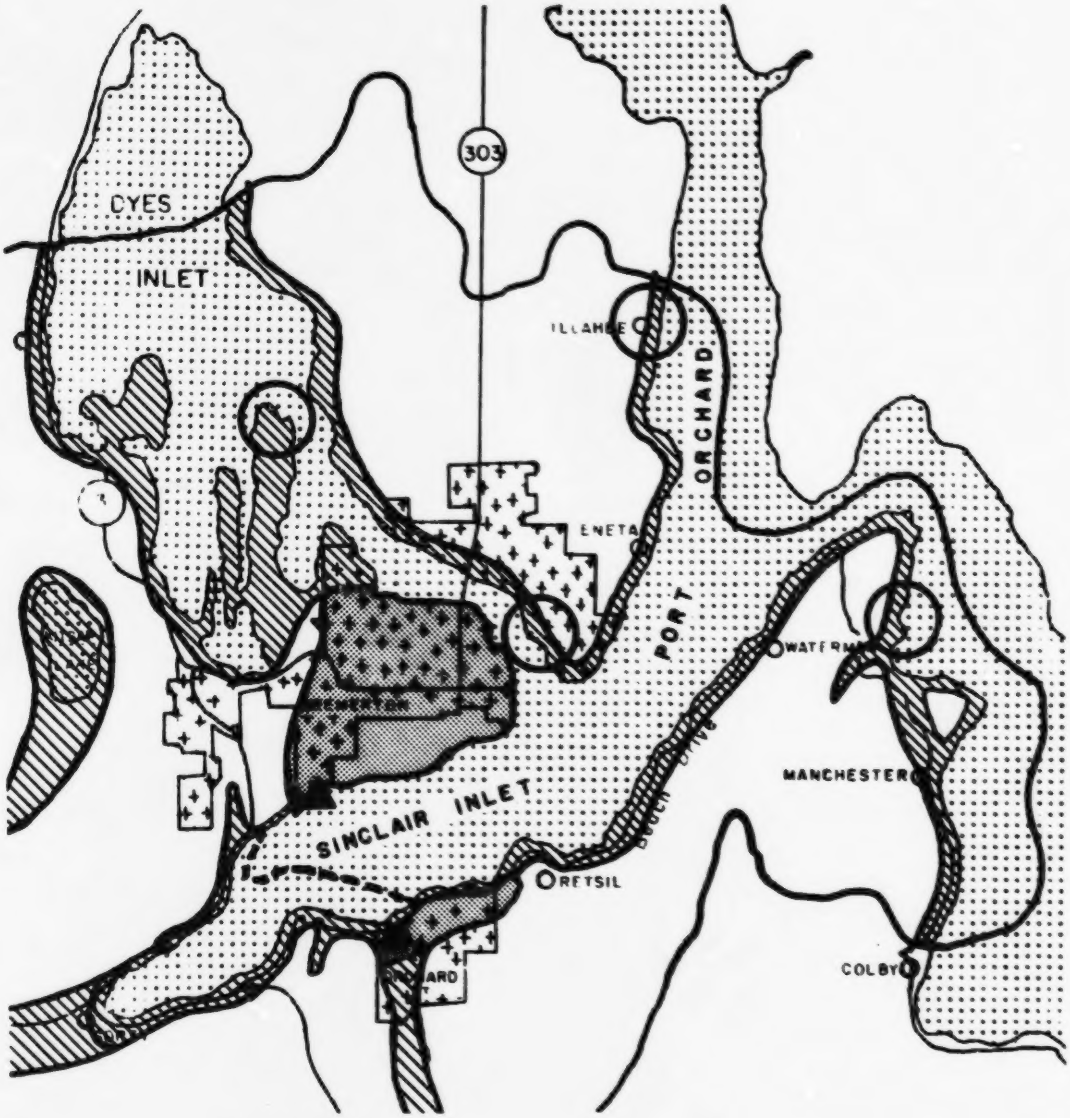
Numerous structures have been recognized by the Kitsap County Historical Society (not part of the Kitsap County government) in Bremerton and surrounding towns. Most buildings listed by the Society were built from 1885 to 1916 (more recent structures are not listed) and are four to eight room residences. A large number of these residences are concentrated in the easterly portion of Bremerton south of the Port Washington Narrows. The proposed corridor for the Manette-Charleston pipeline does not pass any structure currently listed by the Society but does pass through an area with residences of equal or greater historic interest which have not been nominated for the Society's list.

Central Kitsap County was initially settled in the 1860's and 1870's following the Civil War and during the great European migrations of that period. Most local development focused on the timber industry and the waterways for transportation from some small farms. Following the plat approval for Bremerton, the U.S. Navy approved the shipyard site and began constructing the Puget Sound Shipyard. Major development of the shipyard also generated considerable development in Bremerton and Port Orchard (or Sidney) which accelerated during the Spanish-American War. Many historic residences of Bremerton date from this period of 1890 to 1916, while those of Port Orchard follow somewhat later, from 1900 to 1916.

Structures in the Manette vicinity and East Bremerton pipeline segment date from the World War II period or later, while the main segment of the Bremerton pipeline passes a mosaic of a few structures which may date from the late 1800's mixed with a large number of 1900 to 1930 houses and a scattering of replacement housing of the World War II period or later. Commercial structures along Callow Street, Naval Street and State Route 21 include some buildings from the 1900-1916 period which have been extensively renovated and many buildings from 1941 to date. Residences along the creek south of the Charleston plant were constructed after 1916 and largely after 1940. These structures do not appear to have any significant historic or architectural importance.

In the Port Orchard area most of the buildings, both residences and commercial buildings, along the corridor were constructed from 1900 to present date. A fire in 1895 destroyed many buildings along the route, and others were built following relocation of the county seat to Port Orchard and the beginning of the active operations of the shipyard across the inlet both during the Spanish-American War and World War I. The site of the Port Orchard plant lies on fill over tidal flats which was placed after 1940 and thus determines the dates of the earliest sturctures. Many houses and a few commercial buildings between Port Orchard and Manchester, along Beach and Hilldale roads, date from the 1900-1930 period, while additional houses and shopping centers (on post-1940 fill) have been added since 1940. Along the east end of Beach Road south to the Manchester plant, structures are well back from the road and from the Manchester plant.

Excavations of pipelines commonly penetrates below the level of modern construction of post-1940 (e.g., 1-2 m depths) and may encounter remains of earlier structures. The potential for such subsurface remains may be inferred from the location of extant structures of the early period, maps and photos. In the Bremerton area, greatest potential would lie along the waterfront near Evergreen Park, along 8th Street and along the perimeter of the shipyard on First Street and Farragut Street. Along State Routes 21 (south of Bremerton) and 160 (in and near Port Orchard), deep fill for the roads and railroad preclude finding significant historic remains below road grades. Depending on the precise routing of the pipeline from Port Orchard to Retsil, the potential for some historic remains increases towards Bay Street. The potential may reflect the probability of finding remains left from the structures destroyed during the fire of 1985. Such potential may extend to Retsil, but the deep fill north of Retsil precludes encountering significant historic remains. No potential existis along Hilldale and Beach roads due either to substantial grading in the Naval reservation at Little Clam Bay or the shallow bedrock and absence of surface accumulations.


DYES
INLET
303
ILLAHEE
ENETA
PORT
ORCHARD
WATERMAN
BREMERTON
MANCHESTER
SINCLAIR INLET
RETSIL
COLBY
ORCHARD

LEGEND

▲ REGISTERED LANDMARKS

○ RECORDED SITES

▒ DISTRICT WITH NUMEROUS STRUCTURES OF HISTORICAL IMPORTANCE

▨ AREAS WITH POTENTIAL ARCHEOLOGICAL SITES

FIGURE E-1 ARCHEOLOGICAL & HISTORICAL RESOURCES WITHIN THE STUDY AREA

# APPENDIX F

## CITY AND COUNTY BUDGETS

The budgets of Kitsap County, Port Orchard and Bremerton are presented in summary form in Tables F-1 through F-6. Expenditures and revenues by source are presented separately for each municipality. A review of the budget expenditures reveals the various activities of each.

The revenue tables indicate sources of funds. It must be noted that in each case, an "Other" category was created to simplify the information presented. This "Other" category represents a large proportion of total revenues for both Bremerton and Port Orchard. However, in both cases, "Other" represents either the sum of a number of smaller sources or has been defined as "Other" in the budget itself.

State-imposed limitations on property tax collections, together with a review of recent trends, are discussed in the section "Tax Base-Assessed Valuation."

The State of Washington imposes a 4.6 percent retail sales tax on a broad base of retail and wholesale transactions, including rentals, leases and certain services (Reference F-1). Counties are permitted to levy an additional 0.5 percent, which is rebated to the city or county where the sale is made (Reference F-2). Little detailed information is available on sales tax histories for the cities of Bremerton and Port Orchard.

Retail sale in Kitsap County doubled in dollar volume between 1971 and 1974 (See Table F-7). However, it should be noted that a portion of this increase is attributable to the sizeable inflation rate experienced during this period. While the proportion of wholesaling has increased and service retail sales decreased, the percentage distribution of other sectors has remained stable (Reference F-6).

## Table F-1. KITSAP COUNTY-1977 BUDGET-EXPENDITURES

| Department | Expenditures | Percent of Total |
|---|---|---|
| Administration Building | $ 224,842 | 3.4 |
| Assessor | 666,033 | 10.0 |
| Auditor | 289,555 | 4.3 |
| Central Services | 207,261 | 3.1 |
| Clerk | 158,310 | 2.4 |
| Commissioners | 192,010 | 2.9 |
| Co-op Extension | 62,893 | .9 |
| District Courts | 286,316 | 4.3 |
| Fair | 167,235 | 2.5 |
| Juvenile | 343,172 | 5.1 |
| KCARP | 527,278 | 7.9 |
| Non Departmental | 700,224 | 10.5 |
| Parks | 170,390 | 2.5 |
| Planning | 334,598 | 5.0 |
| Prosecuting Attorney | 404,156 | 6.0 |
| Sheriff | 938,361 | 14.0 |
| Superior Court | 320,690 | 4.8 |
| Treasurer | 230,598 | 3.4 |
| Building Code Compliance | 372,802 | 5.6 |
| Boundary Review, Coroner, Board of Equalization, Noxious Weed Control, Central Reproduction, and Civil Service | 95,950 | 1.4 |
| TOTAL | $ 6,692,674 | 100.0 |

Source: Reference F-3.

### Table F-2. KITSAP COUNTY-1977 BUDGET-REVENUES

| Source of Revenue | Revenue | Percent of Total |
|---|---|---|
| Property Taxes | $ 2,151,709 | 32.1 |
| Retail Sales & Use Tax | 900,697 | 13.5 |
| Building licenses & Permits | 315,423 | 4.7 |
| Departmental Fees & Charges | 702,399 | 10.5 |
| Motor Vehicle Licenses | 220,000 | 3.3 |
| Other (Miscellaneous Revenue, Community Events, Non-Revenue) | 612,181 | 9.1 |
| Intergovernmental Revenue | 1,418,615 | 21.2 |
| Investments and Interest | 340,000 | 5.1 |
| Other Taxes and Earnings | 31,650 | .5 |
| TOTAL | $6,692,674 | 100.0 |

Source: Reference F-3.

## Table F-3. CITY OF PORT ORCHARD - 1977 BUDGET - EXPENDITURES

| Fund | Expenditures | | Percent of Total |
|---|---|---|---|
| Current expense fund | | | |
| Fire | $ 64,356 | | |
| Police | 175,020 | | |
| Library | 23,384 | | |
| Finance & administration | 45,908 | | |
| Other | 183,701 | | |
| Total current expense fund | | $ 492,369 | 27.5 |
| Street & street improvements | | 178,672 | 10.0 |
| Arterial street fund | | 91,703 | 5.1 |
| Federal Shared Revenue | | 145,800 | 8.1 |
| Water - sewer, utilities & bonds | | 656,100 | 36.6 |
| Miscellaneous | | 227,002 | 12.7 |
| Total | | $ 1,791,646 | 100.0 |

Source: Reference F-4.

## Table F-4. CITY OF FORT ORCHARD - 1977 BUDGET - EXPENDITURES

| Sources of revenue | Revenue | Percent of Total |
|---|---|---|
| General property taxes | $ 221,077 | 12.3 |
| Retail sales tax | 160,000 | 8.9 |
| Business taxes | 101,075 | 5.6 |
| Licenses & permits | 13,772 | 0.8 |
| Inter-government revenue | 439,043 | 24.5 |
| Charges for service | 19,040 | 1.1 |
| Fines & forfeits | 19,000 | 1.1 |
| Water charges | 136,000 | 7.6 |
| Sewer charges | 100,000 | 5.6 |
| Miscellaneous revenue | 93,113 | 5.2 |
| Other (services, interest, non-revenue receipts, etc.) | 489,526 | 27.3 |
| Total | $ 1,791,646 | 100.0 |

Source: Reference F-4.

## Table F-5. CITY OF BREMERTON - 1977 BUDGET - EXPENDITURES

| Fund | Expenditures | | Percent of Total |
|---|---|---|---|
| General fund: | | | |
| Fire | $ 1,111,564 | | |
| Police | 1,347,020 | | |
| Park | 458,522 | | |
| Treasurer/Accounting | 291,474 | | |
| Other | 2,291,007 | | |
| Total general fund | | $ 5,499,587 | 37.1 |
| Street & parking | | 2,134,124 | 14.4 |
| Water/sewer fund | | 2,634,130 | 17.9 |
| Other water/sewer (bond funds, cumulative bond reserve and redemption funds, construction funds) | | 1,616,365 | 10.9 |
| Municipal transit | | 561,000 | 3.8 |
| Federal Revenue Sharing & CETA | | 631,260 | 4.3 |
| Cumulative reserve general municipal purposes | | 611,450 | 4.1 |
| Library bond G.O. | | 44,199 | 0.3 |
| Pension, police & fire | | 361,000 | 2.4 |
| Miscellaneous funds | | 717,764 | 4.8 |
| Total | | $ 14,810,879 | 100.0 |

Source: Reference F-5.

## Table F-6. CITY OF BREMERTON - 1977 BUDGET - REVENUES

| Sources of revenue | Revenue | Percent of Total |
|---|---|---|
| Property tax | $ 1,038,693 | 7.0 |
| Retail sales tax | 850,000 | 5.7 |
| Business tax | 963,500 | 6.5 |
| Other tax | 203,000 | 1.4 |
| Parking revenue | 245,000 | 1.7 |
| Motor vehicle fuel & excise tax | 872,854 | 5.9 |
| Other state shared revenue | 766,175 | 5.2 |
| Licenses & permits | 106,390 | 0.7 |
| Other intra-government revenue (includes state & federal grants & revenue sharing) | 1,659,240 | 11.2 |
| Non-government grants | 182,665 | 1.2 |
| Transit revenue | 250,000 | 1.7 |
| Water/sewer sales | 2,239,900 | 15.1 |
| Other (includes bonds, interfund transfers & miscellaneous) | 5,433,462 | 36.7 |
| Total | $ 14,810,879 | 100.0 |

Source: Reference F-5.

## Table F-7. TAXABLE RETAIL SALES, 1971-1975
($1000)

| | 1971 | 1972 | 1973 | 1974 | 1975[1] |
|---|---|---|---|---|---|
| Retail Sales | $101,618 | $161,758 | $177,082 | $205,520 | $110,534 |
| Percent | 76.4 | 75.8 | 74.4 | 73.1 | 74.4 |
| Services | 9,263 | 12,406 | 12,485 | 14,743 | 7,127 |
| Percent | 7.0 | 5.8 | 5.3 | 5.2 | 4.8 |
| Contract Construction | 14,619 | 24,661 | 29,438 | 39,197 | 19,443 |
| Percent | 11.0 | 11.6 | 12.4 | 13.9 | 13.1 |
| Manufacturing | 1,859 | 3,960 | 4,463 | 5,185 | 2,602 |
| Percent | 1.4 | 1.9 | 1.9 | 1.9 | 1.8 |
| Transportation, Communication, Utilities | 949 | 1,340 | 1,470 | 1,863 | 903 |
| Percent | 0.7 | 0.6 | 0.6 | 0.7 | 0.6 |
| Finance, Insurance, Real Estate | 973 | 1,533 | 1,431 | 1,861 | 809 |
| Percent | 0.7 | 0.7 | 0.6 | 0.7 | 0.5 |
| Wholesaling | 3,204 | 6,242 | 9,761 | 10,773 | 6,057 |
| Percent | 2.4 | 2.9 | 4.1 | 3.8 | 4.1 |
| Other | 584 | 1,514 | 1,735 | 1,989 | 983 |
| Percent | 0.4 | 0.7 | 0.7 | 0.7 | 0.7 |
| TOTAL | $133,069 | $213.414 | $237,863 | $281,132 | $148,458 |
| Percent | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

1. First half-year

Source: (Reference F-6)

## CHAPTER II

## REFERENCES

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F-5. Bremerton, City of, Official Budget, 1977, Bremerton, Washington, October 6, 1976.

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# APPENDIX G

## SHORT-TERM IMPACTS

## G-1 MARINE ENVIRONMENT IMPACTS

### Pipeline Routes

Terrestrial pipeline construction and subsequent erosion and sedimentation will have localized effects in Sinclair Inlet. The sediment load in the water could have a short term effect on photosynthetic plants and filter-feeding animals. These effects should be limited to the construction period plus a few months to half-a-year for the bioregeneration lag time.

In most of the alternatives, pipelines could be laid across the intertidal beaches of Sinclair Inlet instead of along proposed terrestrial routes. The installation of pipelines would involve excavation and dredging across intertidal and subtidal lands to an approximate depth of 1-2m (3-6 feet) below the surface of the substrate. A trench of this depth would cause a horizontal surface disturbance of 2-3m (6-9 feet) on each side of the pipeline. Thus, pipeline construction would disrupt the benthic community over a 4-5m (12-15 feet) wide corridor over the length of the submerged pipeline.

### Benthic Community Effects

The removal of the substrate will significantly disrupt the benthic community within the pipeline corridor. Burrowing organisms, such as clams and worms, that live in the area to be excavated will be removed from their burrows and exposed to predatory organisms and/or covered with sediment from the trenching process. Burrowing and attached organisms living in the trenched area or next to it will be disturbed by increased turbidity and silt. Some organisms may not be able to feed or respirate. Generally, substrate removed in the trenching process is replaced as close to its original location and condition as possible unless further soils investigations indicate that a significant change from original conditions would result. In that possibility, special engineering could ensure the intrinsic properties of the substrate.

Although it is not possible to quantitatively determine the extent of construction impact upon benthic organisms, even the worst possible case, which would be total elimination of benthic organisms, should not last long after construction completions. The first to move into the pipeline construction areas would probably be motile animals such as starfishes, crabs, and other crustaceans. Burrowing and attached animals will begin to recolonize the area after the particular species' spawning season. In most cases, recolonization would be within a year.

Algae will also recolonize within a year, usually during spring or summer. If the pipeline route goes through eelgrass beds, the rooted eelgrass adjacent to the disturbed areas will spread vegetatively as well as by seeds. Once algae and eelgrass has recolonized, many animal species will be able to recolonize also. The benthic community will change in species composition, diversity and population for several years following the construction, until it reaches a relatively stable climax community determined largely by the type of substrate following the construction.

The dredging, construction and backfilling of pipelines will create a turbidity plume in the vicinity of, and downcurrent of, the construction area. Turbidity reduces the depth to which sunlight can penetrate, therefore it will have an adverse effect on the photosynthetic properties of phytoplankton (one-celled, drifting algae), benthic algae and eelgrass. Another effect that the turbidity can have on phytoplankton production has been researched by Sherk (Reference G-1). The flocculation and aggregation of temporary suspensoids can mechanically trap phytoplankton and carry them to the bottom.

The suspended sediments will also have some effect on animals in the impacted area. Westley, et al noted that suspended sediments can cause some disorientation of juvenile pink salmon (Reference G-2). Studies in British Columbia indicate that silt loads above 4,000 ppm will prevent salmonids from moving (Reference G-3). The suspended sediment can also bring about a gill irritation that, while not lethal in itself, can make the fish more vulnerable to infection by fungi and pathogenic bacteria.

Turbidity and the resultant increase in temperature in the upper water layers may have short-term effects on juvenile salmon. Optimum conditions for juvenile salmon as determined by commercial salmon aquaculture is 12.5 - 13.5°C in protected inlets with good circulation (Reference G-3). Temperatures above 15°C which seasonally occur in the shallower part of Sinclair and Dyes Inlet increases the risk of disease. Several species of salmonids are present in the study area and would be affected by the above factors.

Dilution by tidal currents and the particle size of the sediment will determine the intensity and duration of turbidity plumes. If sediment size is assumed to be similar, the turbidity would be dispersed fastest in those areas where tidal currents are fastest. Efficient dilution will result in spreading the turbidity over wider areas in a decreased concentration; however, turbidity will not be completely eliminated.

The settling of sediment from the turbidity may have some effect. Sediment disposition should not be heavy enough to have an appreciable effect on the benthic community except in the area close to the construction.

During the construction period, there may be some impact if oil or diesel fuel is spilled from the construction and dredging vessels. Any such spills would be harmful to marine life and illegal. The Rivers and Harbors Appropriations Act provides for these contingencies. Precautions against spills can be included in the construction contract(s) awarded.

## Effluent Discharge

Most of the effects of effluent discharge from the outfalls will be long term in nature because of the continuous nature of treatment processes. These impacts are discussed in the section dealing with long term impacts. Some short term impacts can be noted however and include but are not necessarily limited to the following:

1. displacement of marine organisms, especially clam beds;
2. short term disruption of populations of littleneck, butter, gaper and bentrose clams, mussels and barnacles;
3. slight vegetational effect on eelgrass and sea lettuce;
4. avoidance of central plume by salmonids and pelagic fish;
5. slight increase in turbidity and associated effects;
6. short term effect on photosynthetic plants and filter-feeding animals by sedimentation-discussed in earlier section;
7. nutrient increase in shallow areas, such as the head of Sinclair Inlet, may cause algal blooms which block light to benthic plants and rob dissolved oxygen from the water when they decompose; and
8. small vegetational mortality rate in central plumes because of increased salinity and/or temperature.

# APPENDIX G-2

## ARCHAEOLOGICAL RESOURCE IMPACTS

### Alternative 2

Adverse effects of this alternative may arise from the construction of an expanded treatment facility at the Charleston treatment plant, and new and larger plants at the Retsil and Manchester sites. Replacement of the Manette plant with a pumping station, reversing of the existing Manette pipelines and construction of new pipeline through Bremerton and south to the Charleston plant would involve existing facilities and construction within disturbed areas. Excavations in the disturbed areas are not expected to pass below the existing disturbed zone and, therefore, should not encounter significant prehistoric artifacts. The three treatment plant expansion sites lie along the banks of creeks at their confluence with the inlet or Puget Sound; therefore, such areas would have a moderate to high potential for discovery of archaeological remains in the remaining undisturbed soils. No precise plans for foundation excavations and site grading are presently available for the alternative planning, thus precise resolution of possible impacts cannot be judged. If this alternative is selected, measures should be taken to review the grading plans and monitor deep excavations and the grading of areas before fills are placed.

Alternate pipeline routing through the subtidal zone between the Port Orchard and Retsil plants would pass through areas of moderate to high potential for encountering archaeological remains. This would affect more seriously archaeological resources than the fully land route. Mitigation could involve monitoring for remains in dredge materials and controlled excavation of, or relocation away from, remains in the proposed alignments.

Enlargement and extension of existing outfalls may pass through relatively undisturbed areas offshore of the creek moutns at the three treatment plants. Such areas during the past probably resembled the natural state of the existing shoreline, therefore, the three outfalls may pass across areas of moderate to high potential for submerged archaeological sites. This potential exists because the sea level has risen during the several thousands of years of Indian occupation of the area. Excavations for such outfall modifications should be monitored in order to insure that remains which may be found can be preserved. Monitoring of this type is necessary because water-logged materials commonly require different preservation measures than those from dryland excavations.

Alternative 2 represents a plan which may have some moderate to moderate-high level of effect upon archaeological resources compared to effects from other alternatives. The amount of pipeline excavation and possible effects is about one-third of that in Alternative 3 but greatly exceeds that in the local concept of Alternative 4.

Alternatives 2, 4 and 5 involve substantial excavations and filling at the Manchester, Retsil and Charleston treatment plants, therefore, their effects upon possible buried resources remain the same. Alternative 3 would involve fewer construction effects at the Retsil site and, therefore, would have somewhat diminished effects compared to Alternative 2. Alternative 2 would involve less excavation for outfall and cross-channel connectors than Alternatives 3 and 4 and, therefore, less potential for disturbing archaeological resources below sea level.

## Alternative 3

Potential adverse effects associated with this alternative arise largely from the expansion of the Charleston and Manchester plants and the long distance of new pipeline excavation required. Little or no adverse effects would arise from the replacement of the Manette, Port Orchard and Retsil plants with pumps, reversing of flow in existing pipelines and much of the pipeline excavation through Bremerton and south to the Charleston plant. Expansion of existing facilities at the Charleston and Manchester plants would require excavation and filling in areas of moderate to high potential for archaeological remains. The submerged connector pipeline across Sinclair Inlet would involve excavation through previously undisturbed sediment which was the shoreline of the inlet when sea level was much lower than at present. Bathymetry of the connector corridor suggests that Gorst Creek may have had a small valley along the northern bank of the inlet and a broad floodplain may have existed on the southern bank. Such an area should have a moderate to high potential for archaeological remains more than 3,000 years old. Underwater excavation for the connector may disturb and destroy such remains without being seen on the surface. If the pipeline would be placed on the bottom without excavation no effects should arise, except for some current scouring.

Excavation for pipelines along the southeast shore of the inlet should generally have little adverse effect upon archaeological remains. The southern segment of the pipeline has slight to moderate potential for archaeological remains along the base of bluffs on Ross Point and at Ross Creek. Depending upon the depth of excavation, trenching could pass below the disturbed roadway zone and encounter archaeological remains. The remainder of the pipeline excavation would lie in artificial fill and along existing subsurface utility corridors; these corridors have little or no potential for archaeological remains, especially those which have not been disturbed. An alternate routing in the subtidal zone between Ross Point, the Port Orchard plant and the Retsil plant would involve large areas which have moderate to high potential for archaeological remains. Such a route would create far more serious effects than the land route.

Expansion of the Manchester plant would involve the excavation and filling along a small creek, and such an area may have a low to moderate potential for archaeological remains, although, again, the boggy character of the area and distance to open shoreline may reduce the potential.

## Alternative 4

The local treatment concept of this alternative would eliminate all potential adverse effects from pipeline construction, but would increase possible effects from treatment plant expansions. Expansion of the Manette plant would have little potential of effect due to the highly disturbed character of the residential land use adjacent to the plant. Expansion of the Charleston plant could result in potential adverse effects from deep excavation, grading of undisturbed areas and filling over the natural soil surface and possible archaeological remains. Replacement of the Port Orchard treatment plant would have no effect since the entire area of the plant site lies on deep artifical fill. If piling or very deep excavations were required for foundations, some possible adverse effects may result by encountering archaeological remains below the fill which would date from a time when sea level was 2 to 4 m (6.5 to 13 ft) below present sea level. Construction activity at the Retsil plant would have a moderate to high potential for encountering archaeological remains, depending upon the depth of excavation and area of filling. The plant is on Annapolis Creek and is close to shellfish and other natural resources which would have attracted early occupation of the area. The degree of disturbance for the existing plant and the nearby roadway may reduce the potential for effects, although deep excavations may pass through the fill and penetrate the buried, but relatively undisturbed, natural soil which may contain archaeological remains.

The absence of pipeline connectors in this alternative greatly reduces the total area of possible adverse effects and concentrates the effects at existing treatment plant sites. Inclusion of the Retsil plant site increases the level of potential adverse effects in Alternative 4 compared to Alternatives 3 and 5 but would be equal to or less than that of Alternative 2. The overall effects of Alternative 4 should be less than those of Alternative 2, similar to those of Alternative 3 and perhaps greater than those of Alternative 5.

## Alternative 5

The long pipelines for this alternative would pass through some areas of moderate potential for archaeological remains below the surface. Replacement of the Manette plant with pumps, reversing of existing pipelines and construction of new pipeline through Bremerton and south to the Charleston plant should have no adverse effects on archaeological remains. Expansion of the Charleston plant, pipeline excavation along Beach Road and expansion of the Manchester plant would occur in areas of moderate to high potential for archaeological remains and, therefore, possible adverse effects would be greatest in these areas. Pipeline construction on land between Port Orchard and Waterman should have only a low potential for encountering archaeological remains in the sterile fills and highly disturbed roadway and utility corridors, while subtidal excavations would have high potential for encountering archaeological remains.

Alternative 5, like Alternative 3, does not include construction of a new Retsil facility and, therefore, would generally have fewer adverse effects compared to the potentials of Alternatives 2 and 4. The balance of the overall effects involve the relatively low potential of the Hilldale and Beach roads' pipeline segments compared to that of the Retsil site. The comparisons have assumed a somewhat higher potential for the Retsil site than for the pipeline segments along Hillsdale and Beach Roads.

# APPENDIX G-3

# HISTORICAL RESOURCE IMPACTS

## Alternative 2

Replacement of the Manette and Port Orchard treatment plants, reversing of flow in existing pipelines and expansion of the Manchester plant should have no direct effect upon historic resources of the area. Construction of the Charleston plant expansion would require the removal of 15 residences (11 rental units) which have little historic importance but may have replaced earlier structures. Four separate residences closest to the plant may date from the early 1900's probably World War I, but the others date from the World War II period. Expansion of the Retsil plant would not involve direct effects upon any existing structure of historic interest. Excavation of the pipeline between the pump replacement at the Port Orchard plant site and the expanded Retsil plant would follow Bay Street in Port Orchard and Waterman (Beach) Road. Such excavations would have a high potential for encountering historic remains from the 1880 to 1900 period.

Excavation of the 6,000 m [20,000 ft] pipeline across Bremerton from Evergreen Park to the west end of the Puget Sound Naval Shipyard would pass through the older portions of Bremerton. Since the town was platted before most of the residences along the route were constructed and most older buildings conform to the existing street plans, excavations within the street right-of-way would not affect any existing structures or remains of earlier strucutres. However, some non-structural historic remains could be expected along such a long expanse, which is more than 2 km (1 1/4 mile) within the town area. Excavations in the subtidal zone should have little effect on historic resources.

The structures and potential historical and other remains below ground surface appear to have no national or state importance and very little local importance. No strucutre of unusual architectural features would be destroyed or greatly disturbed by the alternative construction. Most structures near the plant sites and along the pipeline corridors are representative of other structures found throughout the area. Remains, which may come from subsurface excavations, e.g., bottles and coins, would be similar to better preserved specimens. Therefore, the significance of possible losses of historic remains and short-term disturbance appears to be low or slight.

Alternative 2 would have similar effects to those of Alternatives 3 and 5, since plant expansions and pipelines would be similar in those areas of greatest historic importance. This alternative would have the potential for greater, but still slight, adverse effects compared to Alternative 4.

## Alternative 3

The replacement of the Manette, Port Orchard and Retsil plants, expansion of the Manchester plant and reversing of the flow in existing pipeline north of Port Washington Narrows would have no adverse effects upon the historic resources of the area. Expansion of the Charleston plant would require the demolition or removal of two rental houses built after 1940 and four residences built after 1900. Excavations for the pipeline through Bremerton, and along Bay Street and Beach Road in Retsil and Port Orchard has moderate potential for encountering historic remains. The pipeline excavations in Port Orchard may encounter some structural remains below ground surface dating from 1880 to 1900 which preceded replacement construction following the fire of 1895. Excavation along the subtidal alternative route would have little or no effect on historic remains.

The structures along the alternative corridors and at facility sites are largely of local interest, and remains from excavations would generally be represented by better preserved examples. Therefore, the significance of possible historic effects is low or slight, both in degree of effect and in the affected remains.

This alternative would have similar, slight effects as found in Alternatives 2 and 5, and a somewhat greater effect than in Alternative 4. The longer pipeline excavation in the Port Orchard area would contribute to greater potential effects in this alternative compared to Alternative 2, while the effects of pipeline construction on the south side of Port Orchard in this alternative may be somewhat greater than the longer pipeline excavation on the north side of Retsil in Alternative 5.

## Alternative 4

Local expansion of treatment facilities at existing sites would cause removal or demolition of additional structures at the Manette plant site. The residences near the Manette plant which would be affected were constructed after 1940 and have little historic or architectural importance. They are similar to many other residences in the general area. Similarly, residences that would be affected at the Charleston plant site consist of two rental houses constructed after 1940 and four that date from 1900 to 1940. No structures would be affected by expansion of the Retsil and Manchester plants. The localized construction would not tend to involve areas of high potential for subsurface historical remains since the areas have been highly disturbed and contain deep fills. Possible effects have little or no significance to local or larger interests.

This alternative would affect the largest number of structures. However, the structures' lack of historic and architectural significance and the absence of any major pipeline construction renders this alternative to be the least damaging of the four considered alternatives. Alternatives 2, 3 and 5 contain pipeline excavations in the Bremerton and Port Orchard areas and similar plant expansion at the Charleston, Retsil and Manchester plant sites.

### Alternative 5

Replacement of the Manette, Port Orchard and Retsil plants, expansion of the Manchester plant and reversal of flow in existing pipelines would have no effect upon historic resources of the area. Expansion of the Charleston plant would involve the removal or demolition of 11 rental houses built after 1940 and four residences built between 1900 and 1940. Subtidal or land excavation of the Bremerton and Port Orchard-Retsil pipeline segments may penetrate areas with some potential for historic remains below ground surface, while the Retsil-Waterman-Manchester segment of Pipeline does not pass through areas with potential for significant historic remains below ground surface. The significance of effects arising from the plant expansions and the pipeline excavations is low since the buildings do not preserve any significant historic or architectural features; most remains from excavations would be damaged examples of better-preserved specimens found in museums or family collections.

This alternative would have similar and perhaps somewhat lesser effects compared to Alternatives 2 and 3. Alternative 4 would probably have less adverse effect compared to this alternative.

## APPENDIX G-4

## SHORT-TERM ECONOMIC IMPACTS

### Public Fiscal Effects

Public revenues associated with the project are expected to be minimal. Construction of the proposed project will generate revenues to Kitsap County and to the cities of Bremerton and Port Orchard. The main source of income will be sales tax collections generated by payroll spending and construction material purchases. Table G-5 in the section titled Indirect Business Effects presents estimates of local payroll and materials costs, representing spending in Kitsap County. If all these dollars were spent on taxable transactions, $11,700 to $13,600, depending on the alternative selected, in sales tax revenues would accrue to jurisdictions within Kitsap County (See Table G-1).

Sales tax is collected by the State and rebated to the city or county where the sale occurs. Therefore, some portion would be collected by the two cities and the rest would accrue to the county. Sales tax rebates projected in the 1977 Kitsap, Bremerton and Port Orchard budgets total $1.9 million. The tax revenue associated with construction spending would represent an increase of 0.6 percent, for Alternative 4, to 0.7 percent, for Alternative 5.

Cities and counties do not generally charge their own sewer departments for building permits or plan checking. At the Charleston site, however, the City of Bremerton will be creating improvements on county land and will be required to obtain a permit (Reference G-4). The charge will be based on the application of two formulas to the total construction cost exclusive of land (See Table G-2). Income to the county will range from $22,400 for Alternatives 2 and 3 to $26,900 for Alternative 5. These amounts represent a potential increase from 5.6 percent to 6.2 percent over Kitsap County 1977 budget estimates for building permit and plan check fees.

### Project Employment - Construction

It is estimated that an average construction force of about 140 employees will be required for each of the various alternatives proposed. Alternative 5 may require a slightly larger workforce than the other three alternatives. Discussions with the facilities planner indicate that the contractor is likely to be based in Seattle or Tacoma. As a result, about 80 percent of construction workers will commute from outside Kitsap County. Total construction payroll is projected to range

Table G-1, PROJECTED SALES TAX REVENUES TO ALL JURISDICTIONS DURING CONSTRUCTION (IN THOUSANDS)

| | Alternative | | | |
|---|---|---|---|---|
| | 2 | 3 | 4 | 5 |
| Payroll Spent in Kitsap County[a] | $ 968 | $1,025 | $ 963 | $1,121 |
| Materials Purchased in Kitsap County[a] | 1,383 | 1,465 | 1,376 | 1,602 |
| Total Spending in Kitsap County[a] | $2,351 | $2,490 | $2,339 | $2,723 |
| Sales Tax to Local Jurisdications[b] | $ 11.8 | $ 12.5 | $ 11.7 | $ 13.6 |

a. From Table 3 , Indirect Business Activity

b. At $.005 per $1.00 (Reference:G-5)

Table G-2 . KITSAP COUNTY BUILDING PERMIT AND PLAN CHECK FEES TO THE CITY OF BREMERTON (IN THOUSANDS)

| | Alternative | | | |
|---|---|---|---|---|
| | 2 | 3 | 4 | 5 |
| Capital Cost | | | | |
| Charleston | $ 9,574 | $11,087 | $ 7,125 | $ 9,574 |
| Manchester | 992 | 992 | 6,049 | 3,702 |
| Transmission Lines | 1,962 | 1,962 | 0 | 1,962 |
| Transmission Pump Stations | 686[a] | 686[a] | 0 | 686[a] |
| Total Cost to Bremerton System | $13,214 | $14,727 | $13,174 | $15,924 |
| Building Permit Fees[b] | $ 13.6 | $ 15.1 | $ 13.6 | $ 16.3 |
| Plan Checking Fee[c] | 8.8 | 9.8 | 8.8 | 10.6 |
| Total Revenue to Kitsap County | $ 22.4 | $ 24.9 | $ 22.4 | $ 26.9 |

a. Includes Manette to Charleston and Park Avenue

b. Building permit fees are charged on capital costs as follows: $887 for the first $500,000 and a dollar for every additional $1,000

c. 65% of building permit fee (Reference: G-6) from $4,850,000 to $5,600,000, depending on which alternative is selected. Approximately 20 percent of payroll, ranging from $970,000 to $1,100,000 is expected to be paid to Kitsap County residents. The following table indicates the number of job years created in Kitsap County:

Table G-3. JOB-YEARS OF EMPLOYMENT CREATED BY PROPOSED PROJECT

| Alternative | Estimated Payroll Kitsap County[a] ($000) | Estimated Workforce Kitsap County[b] |
|---|---|---|
| 2 | 968 | 19 |
| 3 | 1,025 | 21 |
| 4 | 963 | 19 |
| 5 | 1,112 | 22 |

[a] See Table G-5

[b] Assumes 1 job-year costs, $50,000, including payroll burden.

### Direct Business Effects - Construction

Table G-4 presents an estimated allocation of capital costs for each alternative. It is estimated that capital costs (less land costs) represent approximately 50 percent labor and 50 percent materials. It is probable that a non-local contractor would be used for construction and that about 20 percent of materials would be locally purchased.

Project payroll, including indirect labor (security and maintenance) is expected to range from $4.8 million (Alternatives 2 and 4) to about $5.6 million (Alternative 5). Only about 20 percent of these workers will reside in Kitsap County.

According to the facilities planner, approximately 50 percent of all capital costs (other than land) represents labor costs, including payroll burden and all indirect labor (such as maintenance and security).

### Indirect Business Effects - Construction

Project construction will generate indirect business effects in the Kitsap County economy as the result of (1) local spending by the contractor for materials and (2) local payroll spending by the construction workforce. This spending will create additional jobs locally.

## Table G-4: ESTIMATED CONSTRUCTION MATERIALS AND LABOR COSTS FOR EACH ALTERNATIVE (\$1,000)

| Cost Components | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 |
|---|---|---|---|---|
| Capital Costs[a] | 16,778 | 17,742 | 17,769 | 19,411 |
| Less land & easement costs[a] | 187 | 163 | 1,263 | 186 |
| | 16,591 | 17,570 | 16,506 | 19,225 |
| Less 16 2/3% engineering, legal, environmental costs, & taxes[b] | 2,765 | 2,930 | 2,751 | 3,204 |
| Costs of improvements | 13,826 | 14,659 | 13,755 | 16,021 |
| Labor cost @ 50% of improvements[c] | 6,913 | 7,325 | 6,878 | 8,011 |
| Payroll @ 70% of total labor cost[d] | 4,839 | 5,127 | 4,814 | 5,607 |
| Payroll spent in Kitsap County @ 20% of total payroll[e] | 968 | 1,025 | 963 | 1,112 |
| Materials @ 50% of total costs of improvements | 6,913 | 7,325 | 6,878 | 8,011 |
| Materials purchased in Kitsap County @ 20% of total material costs[f] | 1,383 | 1,465 | 1,376 | 1,602 |
| Total payroll & materials spending in Kitsap County | \$2,351 | \$2,490 | \$2,339 | \$2,723 |

a. From facilities plan

b. Engineering, legal, environmental costs are estimated at 20% of costs for treatment plant equipment, pipelines, pump stations (including building, controls, pumps, motors, support facilities). It follows that costs for engineering etc. are 16 2/3 of total construction costs.

c. From facilities planner (Reference: 4).

d. Assumes 30% of labor cost for burden.

e. Assumes that 20% of labor force will reside in Kitsap County and spend payroll locally for goods, services, housing, etc.

f. Assumes that 20% of materials will be purchased in Kitsap County.

Table G-5. INDIRECT JOBS CREATED IN KITSAP COUNTY BY LOCAL SPENDING FOR CONSTRUCTION

| Components | Alternative | | | |
|---|---|---|---|---|
| | 2 | 3 | 4 | 5 |
| Payroll Spent in Kitsap County ($000)[a] | 968 | 1,025 | 963 | 1,121 |
| Materials Costs, Spent in Kitsap County | 1,383 | 1,465 | 1,376 | 1,602 |
| Total Spending in Kitsap County[b] | 2,351 | 2,490 | 2,339 | 2,723 |
| Total Job-years of Employment Created | 67 | 71 | 67 | 77 |

a. From Table G-5.

b. Assumes that $1 million of additional income in Kitsap County produces an additional 28.7 service jobs; estimate based on analysis provided by David Bogucki, Trident Coordination Program (Reference G-5).

Based on data supplied by the facilities planner, 20 percent of construction materials is expected to be purchased in Kitsap County. Depending upon contractor sources of construction materials and local availability at the time of construction, the actual proportion may be as high as 50 percent or as low as 10 percent. Indirect employment due to construction purchases should be scaled accordingly.

It is assumed that local construction workforce employment will be about 20 percent of total employment. This estimate assumes a Seattle or Tacoma-based contractor will be selected. As the current unemployment in the Kitsap County area is about 8 percent, this project would have a beneficial effect upon local employment.

This analysis assumes that 50 percent of construction costs, less land purchases, represents labor and 50 percent represents materials. Details of the analysis discussed above can be found in Table G-5. Job years of local indirect employment generated by construction activities are projected as follows for each alternative:

| Alternative | Job Years of Employment |
|---|---|
| 2 | 67 |
| 3 | 71 |
| 4 | 67 |
| 5 | 77 |

## REFERENCES

## APPENDIX G

### Short-Term Impacts

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